ENGINEERING AND MINING JOURNAL

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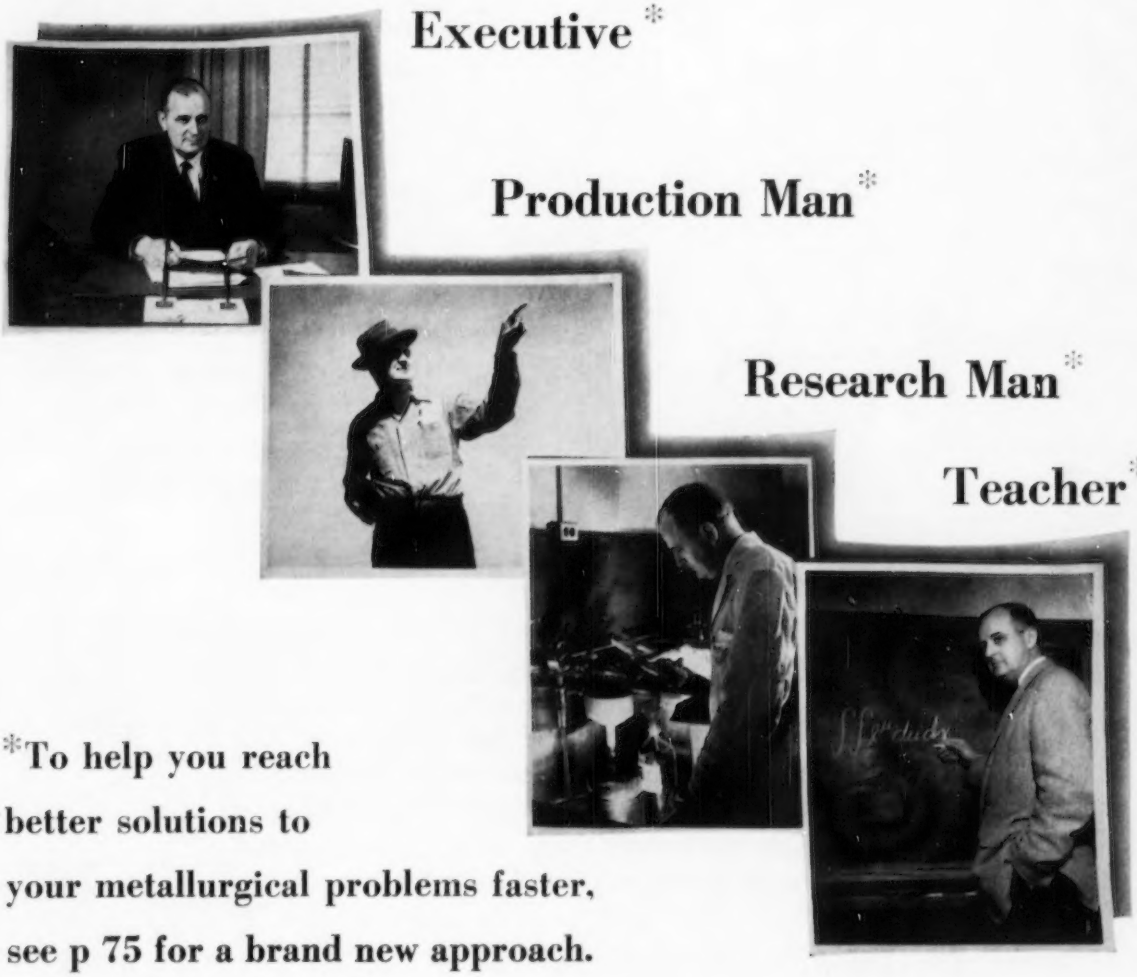


Executive*

Production Man*

Research Man*

Teacher*

*To help you reach better solutions to your metallurgical problems faster, see p 75 for a brand new approach.

Also in This Issue:

Complete Rundown on Solids-Gas Contacting Operations p 78

Peru—Bright Promise for Mining Capital p 94

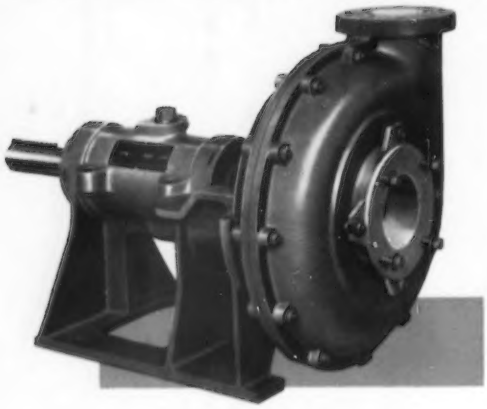
Oxidized Copper—How Much Is Available for the Future? p 97

The hottest find in the uranium fields

...UNITED STATES

...CANADA

...SOUTHERN AFRICA



CENTRISEAL Slurry Pump

Operating entirely without sealing water, it delivers the pulp UNDILUTED.

It is interchangeable with the new
HYDROSEAL Slurry Pump

Because their acid slurries must not be contaminated, uranium mines are finding Centriseal pumps to be the answer to their common need for efficient operation with economy. With close clearances protected from abrasive wear by auxiliary vanes instead of sealing water, Centriseals deliver pulp undiluted. Their wearing parts of molded rubber or Neoprene outlast metal equivalents many, many times, and are as easily replaced as the tube in a tire. Write us about *your* abrasives-handling problem.

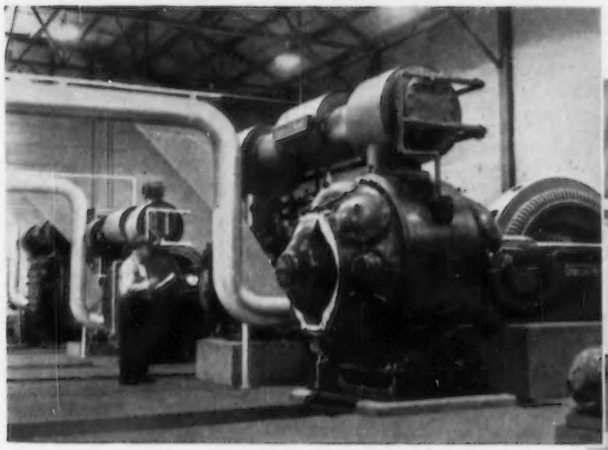
THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. B—259 E. Lancaster Ave., Wynnewood, Pa.
Representatives throughout the World

ASH

CENTRISEAL and HYDROSEAL
SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

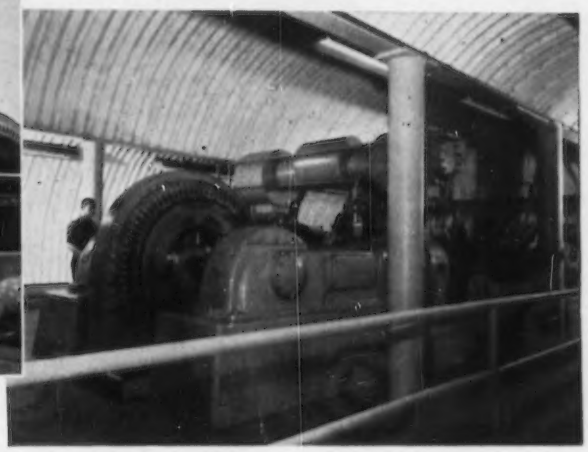
11,000 ft UP
or 4,000 ft DOWN

Ingersoll-Rand PRE Compressors keep rock drills working at top efficiency



Installed at an elevation of 11,500 feet above sea level, three 800-horsepower and two 600-horsepower Ingersoll-Rand PRE compressors, two of which are shown here, supply 100-psi air for Ingersoll-Rand rock drills at Climax Molybdenum Company's two-level development mining at Climax, Colorado. The modern compressor building is located on the surface, directly above the mine workings, which contributes to maximum efficiency for air distribution.

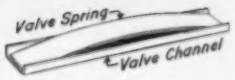
This dependable supply of air power helps keep pressure up to 90 to 100-psi at the cutting faces, thus assuring optimum results for the drilling operations which enable Climax to produce approximately 30,000 tons of ore per day.



Way down underground on the 1200 level, this 400-horsepower Ingersoll-Rand PRE compressor and two smaller units provide 100-psi drilling air for zinc and lead mining operations in Bunker Hill's Star Mine in the Coeur d'Alene district in Idaho.

Located 1200 feet below the shaft collar, these units feed into the same air line as another PRE unit on the *4,000 level.* With dependable I-R compressors at both ends of the system, line losses are reduced and full pressure is maintained at the drills.

Only I-R Compressors have CHANNEL VALVES



- High Efficiency
- Quiet Operation
- Remarkable Durability
- Air-Cushioned Action
- Corrosion-Resistant
- Channels are rigid
- Entirely different

Ingersoll-Rand PRE Compressors, of the horizontal, double-acting crosshead type, are heavy-duty machines built for continuous full-load service. Their extra stamina and low maintenance are big assets in mining service. The completely sealed frame keeps out dust and dirt. Running gear requires no internal adjustments.

Pipeless force-feed lubrication cuts operating and maintenance costs. These and many other features make the PRE an ideal compressor for use wherever large volumes of air are to be handled and pressures must be maintained within close limits over the complete capacity range. Ask your I-R representative for complete information.

Ingersoll-Rand

1-431

11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS

ENGINEERING AND MINING JOURNAL

90th YEAR OF PUBLICATION

VOL. 157 NO. 7

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LETTERS

Engineering Underpaid

I have read with interest your campaign to improve wages for engineers in the mineral industries. After just receiving my May issue of *E&MJ* and noting a particular ad on pages 16 and 17 and also your article "CIMM Probes Engineering Shortage," I felt you might be interested in a few comments from a recent (1952) mining graduate. The first thing I will say is don't go into mining for the money. That old saying that you have to be crazy to be a miner still holds.

In regard to recent appeals of educators to drum up candidates for engineers in the mineral industry, I would like to take exception to the so-called average salary range cited for engineers.

The only engineers I have ever heard of that were making around $10,000 a year ten years after graduation were either born or married into some vice president's family. The rest of us less fortunate souls would consider ourselves fortunate to be drawing down the $7,500 they schedule for only a five-year shift in the salt mines.

In actual cash paid, those in the mining field generally do as well as engineers in other fields, until one looks below the surface. The mining engineers have to work 44 or 48 hour weeks for their money while most other engineers work only a 40 hour week. On an hourly basis the average mining engineer after four years of college will make for about the first five or six years after graduation, give or take a few cents, the same as the average truck driver on the same job, with the exception that the truck driver will get paid holidays. This is something unheard of in the engineering profession.

On the last job that I was on, the engineers got Christmas Day off by the grace of the general manager, and Labor Day off because the union refused to work on that day.

The rest of the holidays were just a red number instead of a black one on the calendar.

From conversations with other engineers, I find that these conditions are not peculiar to just one or two locations, but are pretty much par for the course.

As a final point, I would like to mention what seems to be a trend in most companies. The engineers are put into a department labeled "Engineering" where they perform surveying and other miscellaneous services, but are generally overlooked when it comes to promotions or wage increases. Most of the promotions seem to come up from the ranks of the miners and equipment operators on the job.

Mining Engineer
Riverside, Calif.

B.F.Goodrich

B. F. Goodrich conveyor belt doubles production, cuts costs 40%

Nyfil fabrics give belts greater strength, yet cost no more

At this big Pennsylvania plant, limestone used to be hauled to the crusher in cars drawn by a locomotive. But the system was too slow and costly.

A conveyor belt was considered. But the company was afraid that the heavy boulders crashing down on it would break the fabric reinforcement, would soon wear out the belt.

They talked it over with B. F. Goodrich engineers, who convinced them that there was a B. F. Goodrich belt that could take this abuse. The belt they recommended is made of B. F. Goodrich Nyfil fabric, so named because nylon is used as cross threads in the fabric to give extra strength without adding weight. B. F. Goodrich belts made with Nyfil are much stronger and so have greater impact resistance and hold fasteners better than belts made with cotton fabric.

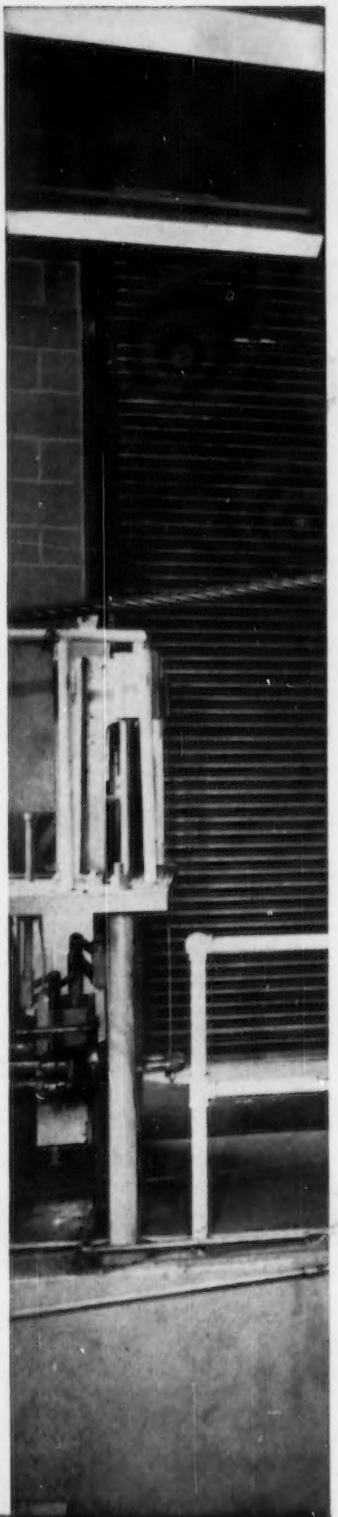
The B. F. Goodrich belt, with Nyfil fabric, had been in use 18 months when the picture was taken, needed no maintenance, looks as if it would last five years more. It has increased production 100%, cut costs 40%, released four men badly needed for other work.

B. F. Goodrich belts, made with nylon-filled fabrics, have been in use many years now and are doing conveying jobs that were once considered impossible. Have your B. F. Goodrich distributor tell you *all* the advantages of belts made with Nyfil, or write *B. F. Goodrich Industrial Products Company, Dept. M-678, Akron 18, Ohio.*

B.F.Goodrich

INDUSTRIAL PRODUCTS

Get longer, lower-cost service from wire rope



Lubricated with Texaco Crater, your wire rope will stay strong longer, no matter how rugged the job it does. *Texaco Crater's* extra-tough film gives each strand sure protection against wear and rust—penetrates right through to the core, too. You're assured of dependable rope service and a real saving in maintenance costs.

Texaco Crater also does a great job on open gears. Its protective film *stays on* gear teeth—provides smooth, quiet operation with far less wear.

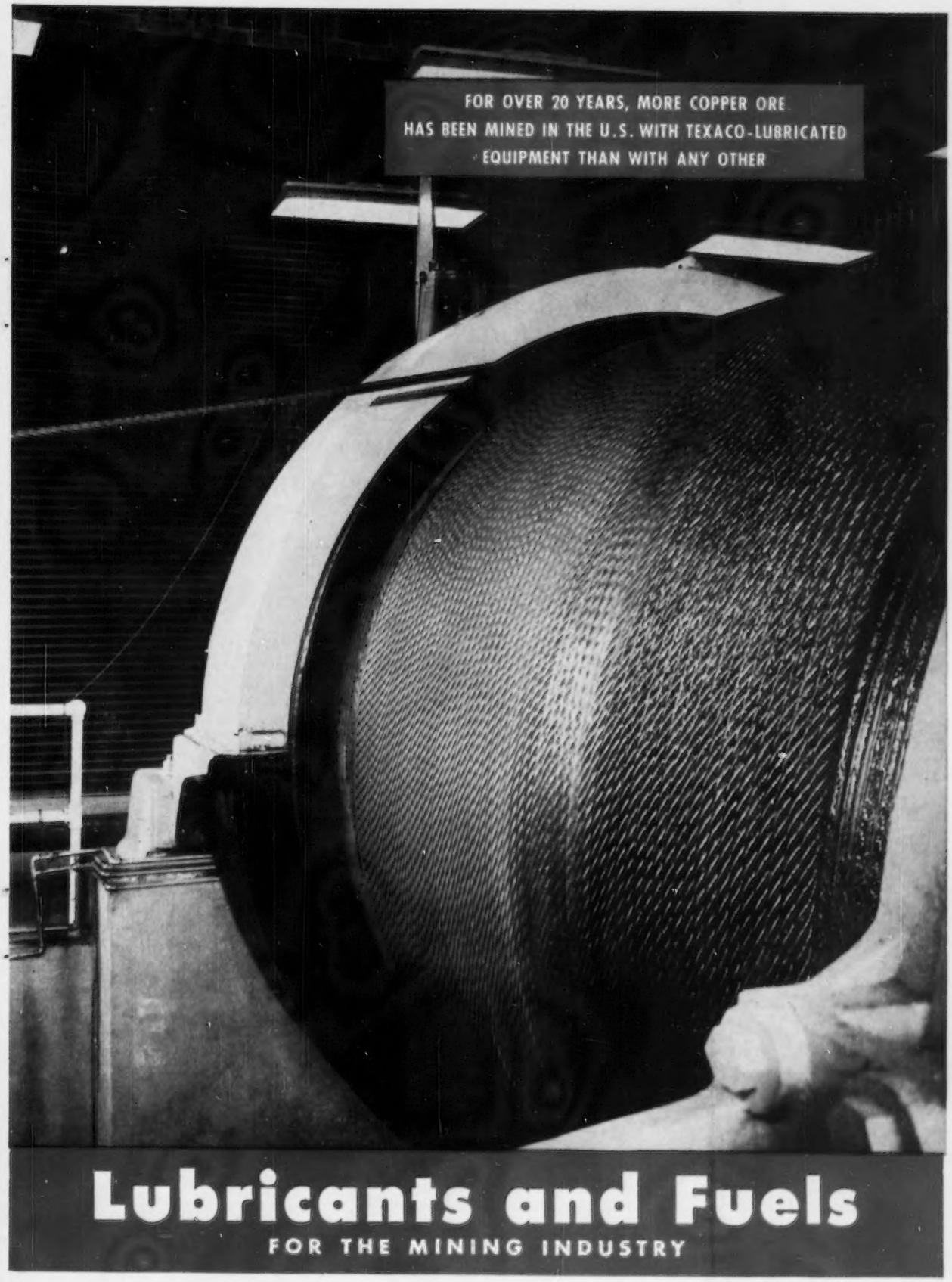
If you prefer the application ease of a fluid lubricant for both wire rope and gears, use *Texaco Crater X Fluid.* It has all the protective, cost-saving properties as regular *Crater.*

For your mine car wheels, use *Texaco Olympian Grease*—the lubricant that assures quick starts, longer bearing life and lower maintenance costs.

A Texaco Lubrication Engineer can help you get more efficient, more economical performance from all your equipment. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO



Lubricants and Fuels

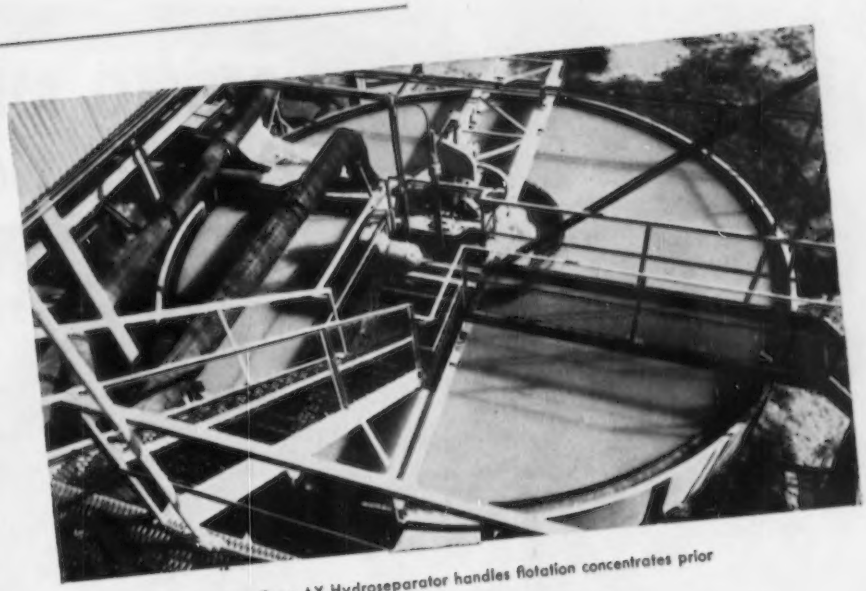
FOR THE MINING INDUSTRY

Look What's Happened to Classification...

Wet classification—important unit operation throughout the process industries—demands special equipment and a wide range of designs. Typical of this trend to specialization is the new, ultra-modern phosphate rock washing plant of Armour Fertilizer Works near Bartow, Florida. No less than nineteen individual Dorr "Classifiers" of five radically different designs are being used for size separation.

1 A Dorr Classifier, upper left, makes a 65 mesh separation with rake product capacity of 240 long tons per hour splitting to two 16½ pocket Dorrco Jet Sizers for further classification ahead of screens.

2 Combined overflow from Classifier and Sizers is treated in this 50′ dia. Dorr Type H-1 Hydroseparator.



4 High capacity Dorr Type AX Hydroseparator handles flotation concentrates prior to further treatment.

3 Desliming at 150 mesh is accomplished in fourteen 24" dia. DorrClone Separators equipped with Vactrol control devices. Units respond automatically to changes in feed . . . produce uniform underflow at 70-75% solids.

Dorr-Oliver is the only manufacturer of a complete line of wet classification equipment. When you call on Dorr-Oliver you can be sure you'll get an unbiased recommendation . . . the *right* equipment to solve your particular classification problem.

DorrClone and Vactrol T.M. Reg. U.S. Pat. Off.

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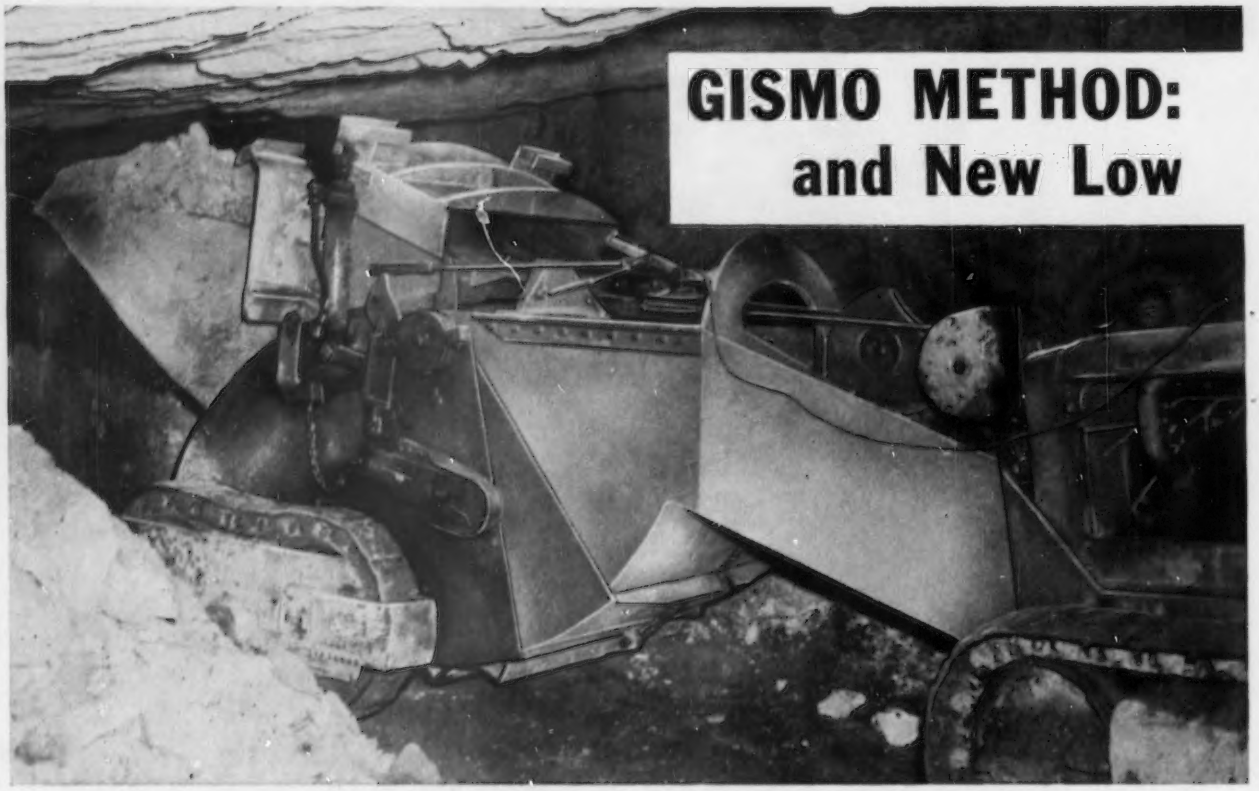
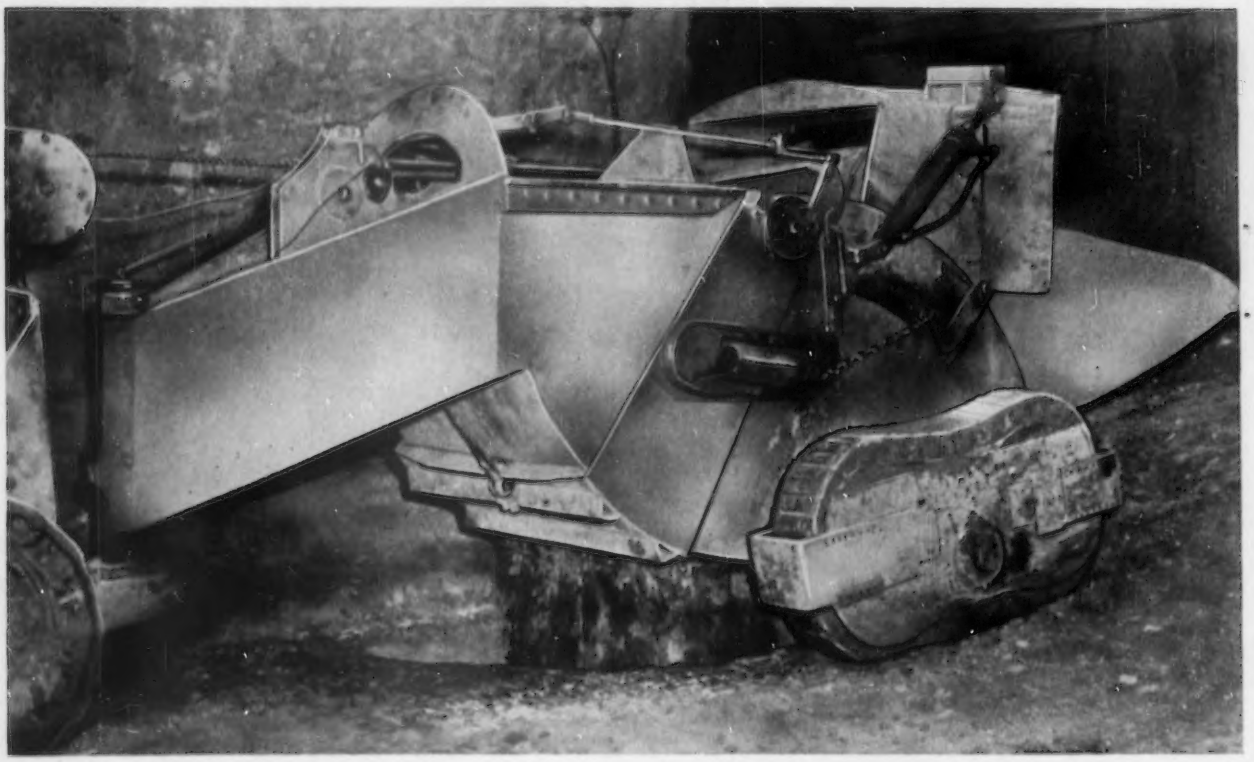
GISMO METHOD: and New Low



LOADS AND TRANSPORTS up to 100 tons per hour with a 300 ft. haul. Gismo loading mechanism is mounted integral with a 6-ton capacity body and an operator controlled dumping device. Above you see Gismo mucking and below dumping at a uranium mine installation. There is no crash or "slam bang" loading. Dipper edge is crowded into the muck pile slowly, similar to methods employed by an experienced hand shoveler.



A Master Plan for Record Tonnages Cost of Developing and Producing!

THIS MASTER PLAN eliminates the need for synchronization between the various phases of mining. Drilling, blasting, loading, hauling and hoisting are kept independent of each other. Delays in any one phase do not set up a chain reaction and result in delays in any or all other phases. Maximum efficiency is assured.

You are going to like the Gismo Method also because it requires few machines, few men, less planning and integration.

Your men are going to like the equipment and the flexibility of its operation. The Gismo itself is a general purpose utility self-loading transport. It is simple, versatile and built to take the punishment of rock excavation. No special development facilities or conditions are usually required. It operates in sloping ore bodies with irregular outlines, as well as large or relatively small openings. It's an unusually simple piece of equipment requiring little maintenance. Its initial cost can be reasonably compared with one year's maintenance cost alone of much of the conventional equipment in present use.

YOU USE SAME EQUIPMENT FOR DEVELOPMENT AND PRODUCTION: A Gismo Drilling Jumbo, a Gismo Self-Loading Transport, a tractor, an incline ramp, any required number of S-D Automatic Bottom Dumping Ramp Cars, a locomotive and track. In production the cars and locomotive are used to transport the ore from surge pocket.

We urge you to investigate the Gismo System and its Master Plan for record tonnages and low cost development and production. We encourage you to compare it with all other methods—involving new or old equipment. It is our opinion that once you make direct comparisons you will recognize that any system without the Gismo Method's Master Plan is obsolete. Write us today for complete information. *Sanford-Day Iron Works, Inc., Knoxville, Tenn.*

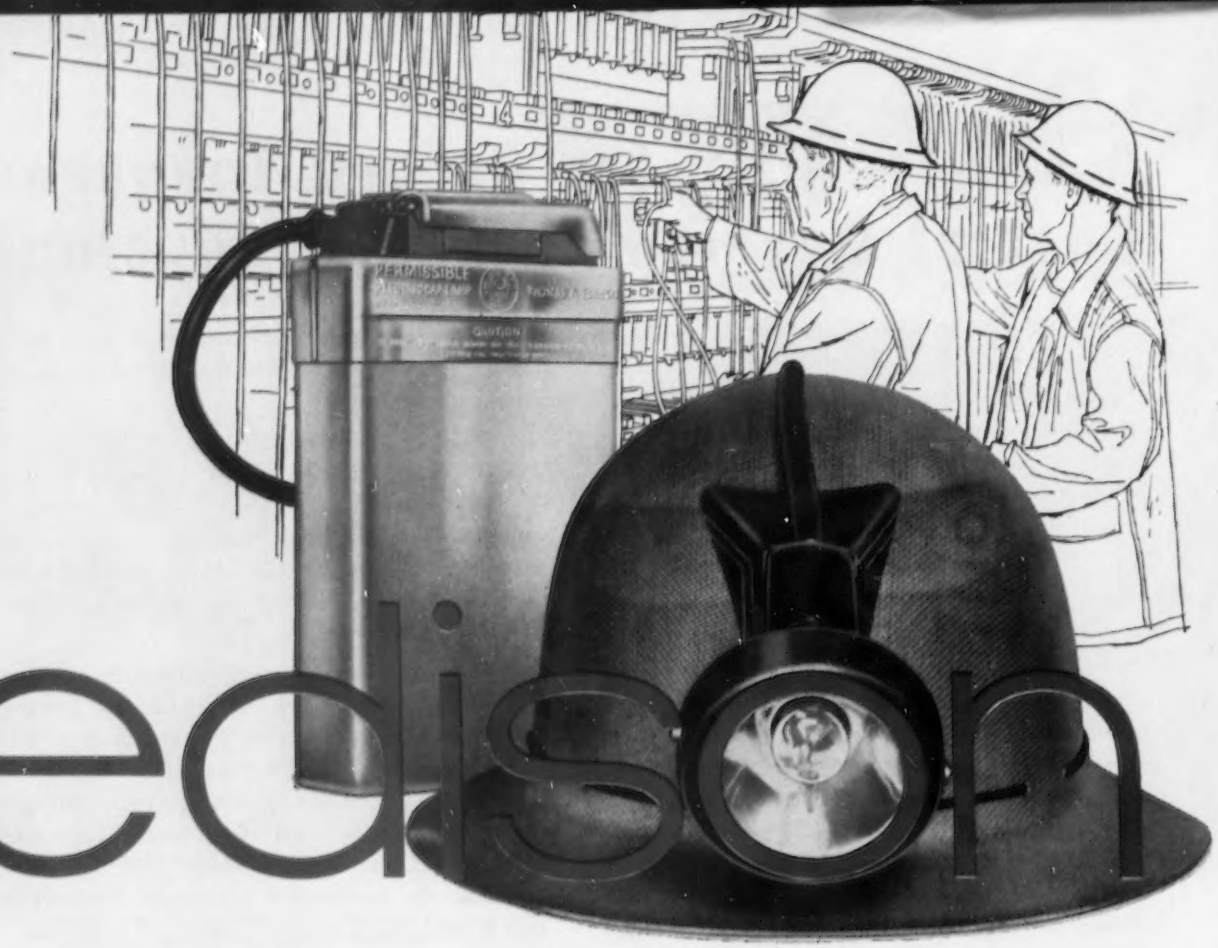
IMPORTANCE OF THE GISMO STOPE DRILLING JUMBO cannot be overlooked. Since it heads up the mine ore extraction process, high-speed drilling and blasting made possible by the Gismo Jumbo is necessary to keep enough rounds available for the Gismo Self-Loader.

TREMENDOUS ECONOMY results from loading directly into S-D Automatic Ramp Cars in tunnel work. In production same cars are used to haul ore from surge pockets. Some of you must be thinking you are reading fantastic ideas, figures and statements. All are very true, real and conservative.

SANFORD-DAY

"SUPER MARKET FOR MINE CARS" — *all types* * PRECISION WHEELS * "BROWNIE" HOISTS, CAR RETARDERS, SPOTTERS, PUMPS AND OIL SPRAY SYSTEMS * GISMO SELF-LOADING TRANSPORT *that loads (mucks) in development or production . . . transports . . . supports 2 to 5 jib mounted drills . . . back fills . . . moves boulder rocks . . . makes its own roadways and cleans up completely — a new method of hard rock mining offering a tremendous reduction in cost per ton!*

5161



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FAST, ECONOMICAL LAMPROOM OPERATION

The miner serves himself! In seconds he has his lamp off the rack, on his belt, and is ready for his shift. And the same holds true when the shift is over. Add it up . . . Edison Self-Service pays off in maximum lamproom economy.

We will be happy to show you how Edison Self-Service can bring economy and efficiency to your lamproom. Write or call for details.

Edison Double Filament Bulb means continued, full light

See that double filament in the bulb? It's your proved protection against lost time for the miner, and a short crew for the foreman. If one filament burns out, a turn of the switch restores continued, brilliant, full illumination—*working light*, not just emergency light!

MSA
SAFETY EQUIPMENT HEADQUARTERS

When you have a safety problem, M.S.A. is at your service . . . our job is to help you!

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pa.
At Your Service: 77 Branch Offices in the United States and Mexico

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
Toronto, Montreal, Calgary, Edmonton, Winnipeg, Vancouver, Sydney, N.S.

14.8 MILLION YARDS TO MOVE, 56 BRIDGES TO BUILD,

IN 29.6 MILE DALLAS-FORT WORTH "SIX-CHUTER"!

Unlike most other turnpikes, the 6-lane Lone Star Speedway is being cut, filled, borrowed and spanned along a populated route, crisscrossed by many heavily travelled roads. To add to contractors' headaches, up to 300,000 gallons of water a day have to be trucked in for compacting. Note how self-propelled scrapers are *tandemed* to tackle the sun-hardened soil. Tires are Goodyear's wide-base Hard Rock Lugs—now standard on much original equipment.

Tire maintenance in field helps construction men beat tight work schedule.

OTHER 3-T NYLON CORD TIRES—CONVENTIONAL OR TUBELESS!

HARD ROCK LUG

HARD ROCK RIB

ALL-WEATHER

SURE-GRIP

ROAD LUG

Look for this nearby Goodyear dealer sign for better tire values—better tire care.

End tube and flap troubles FOREVER!

Specify Goodyear 3-T NYLON CORD *TUBELESS TIRES* on new equipment of every size!

Goodyear tubeless tires and rims are now *standard* on foremost original equipment—or supplied on specification.

In them, you get the regular Goodyear cost-cutting features PLUS many *new* savings of time, trouble and tire-cost-per-yard, possible only with Goodyear TUBELESS.

TO MENTION JUST A FEW: No tube or flap troubles—no tube replacements—easier mounting and dismounting—airtight assembly—cooler running—slow leaks instead of blowouts—easier repairs—simpler, re-usable valve-parts.

Get all the facts from your helpful Goodyear dealer. Goodyear, Truck Tire Dept., Akron 16, Ohio.

Buy and Specify **GOODYEAR**

MORE TONS ARE HAULED ON GOODYEAR TRUCK TIRES THAN ON ANY OTHER KIND

Road Lug, Sure-Grip, All-Weather—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

TWO GREAT NAMES

Teamed For Quality...Service...Progress

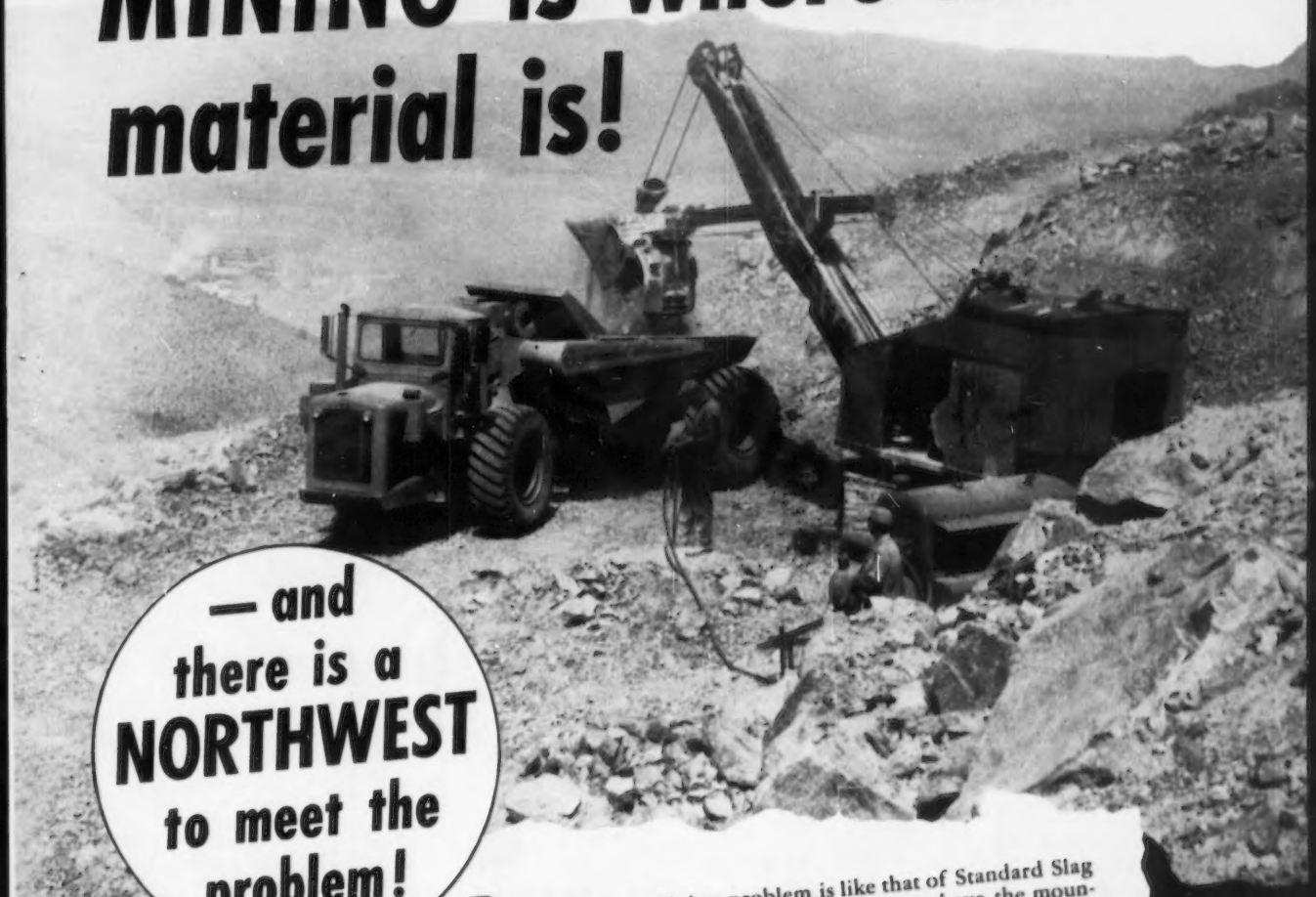
Two steelmakers, each known for its achievements in its own particular field of producing forged and annular rolled products are now combined to supply requirements of the largest and smallest. Two groups of production and research engineers are joined to better serve American industry. The new company is a totally owned subsidiary of Heppenstall and will operate independently. Each company will continue to offer American industry the custom made products for which it is famous.

MIDVALE - HEPPENSTALL CO.

NICETOWN
PHILADELPHIA 40, PA.

A SUBSIDIARY OF HEPPENSTALL COMPANY

MINING is where the material is!



— and there is a NORTHWEST to meet the problem!

A Northwest Shovel high in the Nevada Mountains handling Magnesite Ore for Standard Slag Co.

PERHAPS your mining problem is like that of Standard Slag Co. at Gabbs, Nevada, where your equipment has to have the mountain climbing ability of a goat. Or maybe you have a sea going job like that of Freeport Sulphur Co. at Port Sulphur, La., where mining is done in inland channels.

The material is where you find it and that's where your equipment has to be.

Northwest Crawler equipment is serving on all kinds of mining jobs. Northwest versatility—its ability to get places and do things a little faster, makes it a cost cutter and time saver whether it's afloat on a barge or handling ore in the pit. Steering with positive traction while turning as well as when going straight ahead, takes it where other machines have difficulty.

A wide range of boom hoist equipment fits you for any condition.

The Northwest Dual Independent Crowd utilizes force most other Independent Crowd Shovels waste.

Uniform Pressure Swing Clutches, the "Feather-Touch" Clutch Control, the Cushion Clutch and other Northwest advantages make it a superior machine in mining work.

Now is the time to learn about Northwest equipment. Plan to have one. Talk it over with a Northwest man.

NORTHWEST ENGINEERING COMPANY
1509 Field Building, 135 South LaSalle Street, Chicago 3, Illinois

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PRODUCTION PLUS · MEANS MONEY ·

NORTHWEST

Convertible for any Mining Material Handling or Excavation Problem

Your Wickwire Rope distributor and our steel melter... always at your service

This steel melter—at Wickwire's open hearths where wire rope steel is made—is with your Wickwire Rope Distributor every time he makes a call.

True, he's physically at the open hearth compounding steel with the sharp eye of an expert. But your Wickwire Distributor makes his call with the full assurance that the steel in Wickwire Rope has the right chemical content and grain size because it's always produced under rigidly controlled conditions by experts.

It's just one more reason why your Wickwire Rope Distributor knows he's got top-quality rope, slings and strand to sell . . . and that these products will serve you well.

CF&I WICKWIRE ROPE A CF&I PRODUCT

4082

A PRODUCT OF THE COLORADO FUEL AND IRON CORPORATION

Dumps in 10 seconds — with power-steer and instant 4-wheel air brakes, Rear-Dump backs safely down 12% grade . . . positions, dumps heaped load, and returns up grade . . . all in less than a minute.

Cuts maintenance, fuel bills "way down"

Reno Construction Co., Overland Park, Kansas, has practically eliminated hauler maintenance at their limestone quarry by replacing a fleet of dump trucks with two D Tournapull Rear-Dumps.

These LeTourneau-Westinghouse rear-dump units, with their welded all-steel construction, have far fewer breakdowns than other haulers on the job. It was not unusual for Reno to have several trucks tied up at once with broken springs, damaged bodies, hydraulic leaks, or tire injuries. Tournapull Rear-Dumps, however, are seldom in the shop for repairs. These rigs use big low-pressure tires instead of springs and spring hangars . . . have no frames, sub-frames, or long drive-shafts . . . no hydraulics, no jack-lines.

"Our Tournapull Rear-Dumps have cut maintenance and fuel bills way down," says Foreman F. P. Thomas. "They have been very satisfactory and economical in operation."

Says Supt. Charles Reedy, "These rigs have relieved us of a lot of maintenance problems. Now we can depend upon steady production with less hauling equipment." Moving screened-rock to a hopper, for example, the 2 Rear-Dumps accounted for 1200 tons in 10 hours, according to Mr. Reedy. Hauls averaged 800 ft. one-way including 250 ft. up a 15% grade.

Stripping cap-rock overburden, these 9-ton "D's" were loaded to capacity in 5 passes of a 1½-yd. shovel. Haul of 725 ft., dump in farmer's field to build stockpond dam, and return of 725 ft. took as little as 4 minutes. With this output, Reno will greatly speed preparation of a 40-acre area. When stripping is done, units will be used chiefly to haul limestone from quarry to crusher. Pit being uncovered will last Reno for years.

If you would like further information on LeTourneau-Westinghouse Rear-Dumps, Scrapers, or other interchangeable work units behind your same Tournapull prime-mover, we will be glad to supply you with production figures, or arrange for you to see these haulers in action. Current Rear-Dumps offer 11, 22, or 35-ton capacity. Call us for names of Rear-Dump users near you.

Tournapull—Trademark Reg. U.S. Pat. Off. DR-407-M-bw

LeTourneau-WESTINGHOUSE Company

Peoria, Illinois

A Subsidiary of Westinghouse Air Brake Company

What the

H & P CYCLONES

are doing for the

COAL INDUSTRY

CHECK THESE ADVANTAGES!

- ☐ Closed circuit operation
- ☐ Recovery of fine coal
- ☐ Prevention of stream pollution
- ☐ Controlled washing water densities
- ☐ Conservation of water
- ☐ Sharp classification for washing operation

H & P Cyclone installations pay for themselves in unbelievably brief periods . . . by reducing the load to, or entirely eliminating sludge ponds, and by increasing the recovery of salable coal.

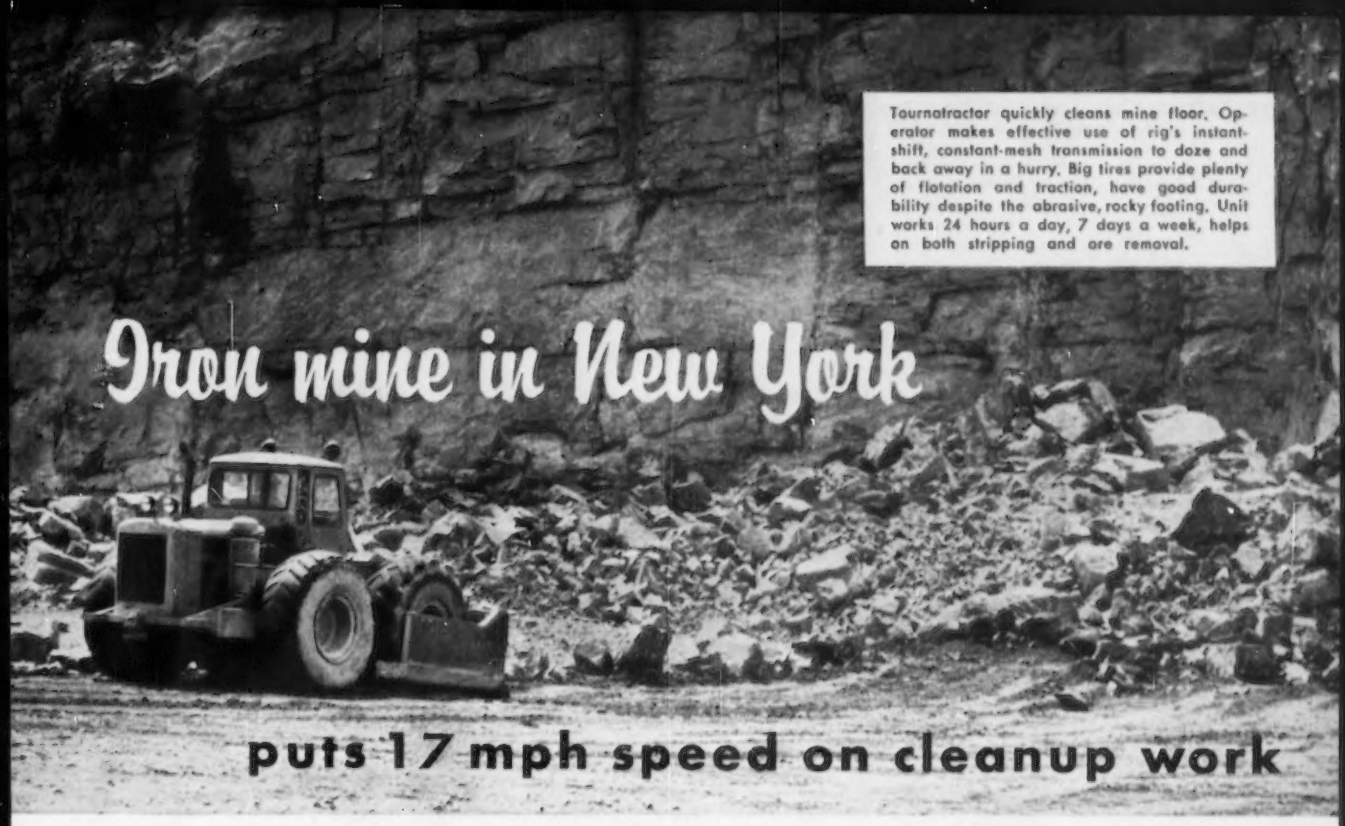
Ten years of progressive research and thousands of H & P Cyclones in operation assure you of the finest cyclones engineered into the best designed clarification circuits.

We will gladly arrange for you to visit plants where H & P Cyclones have increased operating profits.

Write for Booklet CT-954.

Heyl & Patterson
INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.
PHONE COurt 1-0750



Tournatractor quickly cleans mine floor. Operator makes effective use of rig's instant-shift, constant-mesh transmission to doze and back away in a hurry. Big tires provide plenty of flotation and traction, have good durability despite the abrasive, rocky footing. Unit works 24 hours a day, 7 days a week, helps on both stripping and ore removal.

Iron mine in New York puts 17 mph speed on cleanup work

- **Rubber-tired tractor clears mine-floor after blasting**
- **Rig also cleans up around 4½-yd. shovel**
- **In winter, plows snow from haul roads and blast areas**

With drilling and blasting done throughout the day along an ore body two miles in length, this New York open-pit iron mine has a major cleanup problem. They have licked the problem with the speed and maneuverability of a rubber-tired Tournatractor.

On the relatively long runs between operating faces, this 17 mph rig makes a much faster trip than could a crawler-tractor. Another advantage of Tournatractor is that it does not cut-up the surface of the haul roads like a crawler does.

During winter, Tournatractor also finds time to plow snow from the pit roads and loading areas. It also clears areas to be blasted. This keeps snow from getting mixed in with the shot rock and later from causing trouble inside the crushers.

"Excellent on night shift"

For work on the night shift, owners are particularly pleased with the lights on their Tournatractor. They find that "night work does not slow this rig nor put any limitations on areas where it can travel or work."

For proof of these advantages, ask for a demonstration *in your pit* of this high-speed 208 hp machine. See for yourself how quickly and how economically it will handle your scattered pushing, pulling and dozing jobs.

The ore body being mined here was discovered in 1810 by engineers surveying a military road between Albany and Ogdensburg. Only a small amount of iron was removed, however, until 1944 when modern methods of beneficiating magnetite and low-grade non-magnetic martite ores made the operation profitable. This year, 1,300,000 gross tons will be processed. All will be taken from a deposit slightly over 2 miles long and 200′ to 1400′ wide. Iron content averages 24%. Overburden includes a structural hanging wall of granetized gneiss, plus up to 60′ of glacial drift (mostly sand, hardpan, and boulders). Height of operating faces is set at 50′ except for some first cuts of 100′. Drilling is made with 42-T and 50-T churn drills, with chrome-nickel-moly bits of 4340 grade. Nine-inch primary holes are spaced about 23′ apart and hurden at toe is kept as close to 20′ as possible. Every pound of explosive breaks about 2.35 gross tons of crude ore. This is loaded by 4½-yd. shovels into 22-ton rear-dumps and transported to the 54 inch primary crusher. Rock chunks too big to pass the 4½-yd. dipper (about 1 chunk per 40 tons of crude ore) are reduced to handling size by a 4-ton drop ball handled by a truck crane.

Tournatractor—Trademark T-751-M-b

LeTourneau-WESTINGHOUSE Company

Peoria, Illinois

A Subsidiary of Westinghouse Air Brake Company

HERE'S 3-WAY PROTECTION AGAINST PRODUCTION LOSSES

You can't buy better Insurance against "downtime losses" caused by faulted power feeders and lighting lines . . . than JOY electrical connectors, portable lighting lines (String-a-lite) and cable vulcanizers provide. Designed by an organization which has been making this type equipment for Metal Mining needs for almost thirty years, these JOY products can be relied on to provide years of dependable, maintenance-free service.

Yours for the asking
WITHOUT OBLIGATION

BULLETIN B56 & B57
Provide complete information on JOY Attachable and Molded-to-cable type connectors.

ELECTRICAL PLUGS AND RECEPTACLES . . . More JOY electrical connectors are used in mining operations than all other brands combined. Factory molded as resilient Neoprene/rubber insulated units, they can't crack or lose shape when struck hard blows . . . are moisture and dust tight . . . and require no pampering to provide a long life of safe, efficient service. Hundreds of styles and sizes are available for mining needs. So for production's sake, remember JOY when you need electrical connectors . . . Bulletin No. B56 provides details. Ask for your copy.

BULLETIN No. B52
Twelve pages of illustrations and descriptions on JOY portable lighting (String-a-lite) and tool-outlet strings.

PORTABLE LIGHTING LINES (String-a-lite) . . . Require no special tools or talents to install or dismantle. Can be quickly lengthened, shortened or moved to meet the exact needs of any working or passage area. Supplied in one-piece factory molded sections of 2 to 10 light outlets that inter-connect through JOY male and female "end-plugs" to make up the complete string. Choice of five socket and two end plug designs. Mating power receptacles also available. Bulletin B52 provides complete details.

BULLETIN No. B48a
Describes and illustrates JOY's complete line of cable vulcanizers, molds and vulcanizing supplies.

CABLE VULCANIZERS . . . for rubber, Neoprene, Buna S and thermoplastic jacketed cables. Simple in operation, JOY vulcanizers quickly pay for themselves by making it possible to repair cuts and breaks in vital portable power lines immediately. Two types are available — "Steam" and "Direct Heat." Both are heated electrically with automatic temperature controls. Bulletin B48a describes these vulcanizers in detail and lists molds vs. cable sizes. Ask us for your free copy.

Consult a Joy Engineer

JOY MANUFACTURING COMPANY
General Offices: Oliver Building Pittsburgh 22, Penna.
In Canada: Joy Manufacturing Co., (Canada) Ltd., Galt, Ont.

JOY
Specialists in Creating Electrical Connectors for Mining Applications, Since 1928

CD 350.3

Four work speeds, 1.8 to 6.4 mph, provide the best power and speed for each particular job assignment.

Today's big news in motor graders

is the all-new 60 hp ADAMS "220"

Here is a low-priced grader with big capacity for hard work. Weighing 14,865 pounds, powered by a 60 hp diesel engine, "220" handles many jobs done by larger machines, saves you money on general grading and road maintenance. Big in value, Adams "220" out-works, out-maneuvers any grader in its size and price class.

Works like a big machine

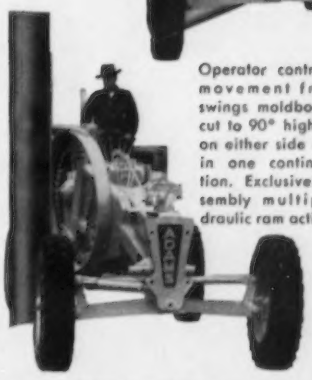
Like the larger Adams machines, the "220" has 4 working speeds under 6.5 mph, and 4 optional "creeper" speeds for full use of engine power in slow, rugged, or precise work. Travels job-to-job up to 18.3 mph.

Blade controls are straight-line-thrust hydraulic. Moldboard swings from ditch-cut to 90° high bank-cut, on either side of grader, in less than a minute, without operator leaving cab. 10-ft. slide-shift moldboard has 6 pitch positions, and reaches 54½" outside wheels. Leaning front wheels, hydraulically operated, offset side thrust, make short turns possible. Wide tread (76" front, 77" rear) gives stability, safety, and easy handling on slopes.

Built like a big machine

"220's" big 10:00 x 24 tires on all six wheels give firm footing and minimum rolling resistance. Sturdy 4-wheel tandem-drive utilizes full engine power, provides push-power and traction for doing many of the heavier jobs. Rugged diesel engine is cranked electrically, starts quickly in all seasons.

Optional cab, open or enclosed type, has 6'4" inside height, floor to ceiling, without use of "foot wells".



Operator controls blade movement from cab, swings moldboard ditch-cut to 90° high bank-cut on either side of grader, in one continuous motion. Exclusive gear assembly multiplies hydraulic ram action, 3 to 1.

Sturdy one-piece, rectangular-welded-section frame, and strong Y-shape drawbar, withstand punishing shocks and stresses. Arched frame provides 17" blade clearance to clear shoulders when climbing out of ditch.

Anti-friction steering, and smooth, fast-acting hydraulic brakes give operator confidence to work or travel at highest practical speed.

Scarifier, power-shift moldboard, 12' moldboards, cab, and other accessories, available as optional equipment.

See Adams in action

We will be glad to prove to you that "220", as well as larger Adams graders, work harder, faster, and at lower cost than other graders of similar size and power. Why not call or write and ask for a competitive demonstration?

Model 220... 60 hp...14,865 lbs.
Model 330... 80 hp...20,500 lbs.
Model 440...104 hp...21,500 lbs.
Model 550...123 hp...23,500 lbs.
Model 660...150 hp...27,730 lbs.

AG-44-G-b

LeTourneau-WESTINGHOUSE Company
Peoria, Illinois
A Subsidiary of Westinghouse Air Brake Company

Westinghouse-equipped ore unloaders break record by 436 ton-hours

Rugged Hevi-duty mill motors and SA brakes take tough shock treatment at 2350 tons an hour

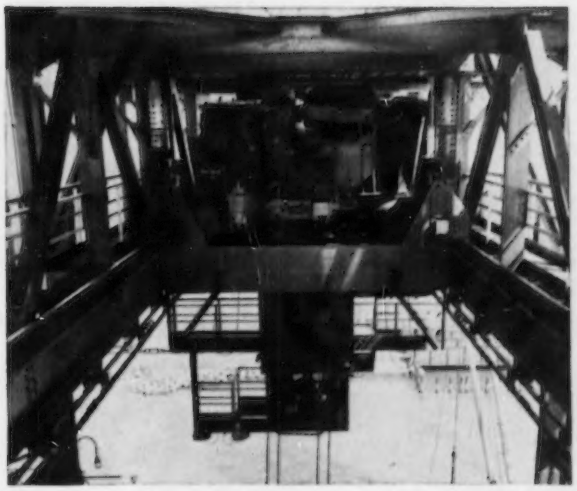
Westinghouse d-c motors with larger shaft diameters between rigid bearing supports are designed and built to break records in rugged operations like this.

This is just one reason why Westinghouse motors were specified by the Pennsylvania Railroad when a new ore unloader was needed to increase the production capacity. Another reason was the superior service record of Westinghouse motors on the unloaders already in use.

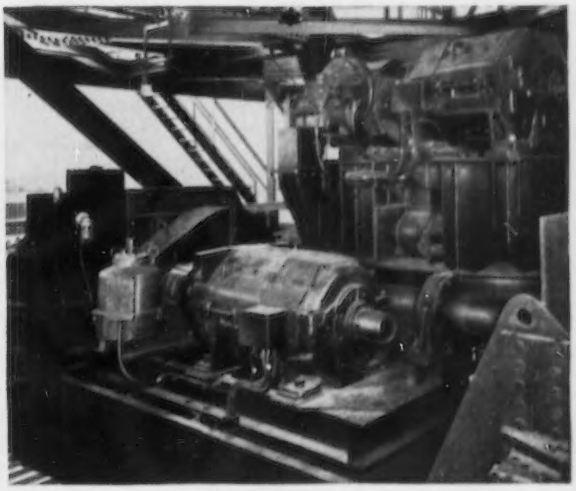
It will pay you to investigate the many other equally important factors about Westinghouse d-c motors and brakes that mean longer life and dependability. You can get all the details from your Westinghouse sales engineer. Call him today. J-21928

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***



Three million tons of ore in 1955 and production is still going up this year! The ability of Westinghouse motors and brakes to stand up under continuous loading and reversing duty makes them first choice for grueling operations like this.



Here is the heart of an ore unloader—Westinghouse Hevi-duty 600 Series mill motors and SA (self-adjusting) d-c brakes. Westinghouse engineers are ready to work with you to determine the characteristics you need for motors, controls and brakes.

Lined . . . and relined with Lorain . . .

Primary clinker mill grinds 37,873,000 bbls. of feed efficiently and economically

At Hudson, New York, the Universal Atlas Cement Company has been using USS Lorain Rolled Steel Plate Linings in its grinding mills since 1938. One 10′ - 6″ x 12′ Preliminator alone has ground 37,873,000 barrels of clinker up to February 13, 1956, consuming only two sets of linings and lift bars.

The first lining in this mill was made of 2″ liner plates and lift bars, Section M-3714, designed to permit replacement of bars during life of the lining. In grinding the 38 million barrels of clinker, one lining and one set of renewal bars were completely worn out. But despite the tremendous tonnage processed, the second lining installed was still in serviceable condition when the mill went down for general repairs in February.

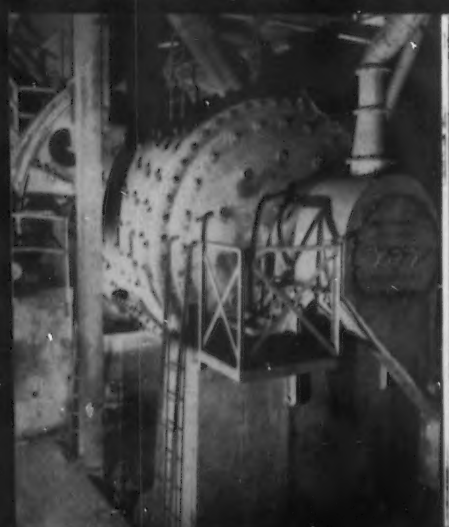
HEAVIER-DUTY LINING—The performance of the original Lorain linings was so impressive that management at Universal Atlas decided to install the latest type Lorain lining with deep recessed liner plates and extra-heavy lift bars, Section M-4497, to further increase the mill's grinding efficiency and to eliminate the need for replacing lift bars. The new type lining was installed during the repair period in February so production would not be interrupted during the peak season this summer. Frankly, no shutdown due to lining problems is expected for the next several years.

LONGER LIFE . . . CONSTANT LIFT—USS Lorain Rolled Plate Linings are made of tough, rolled steel that means longer grinding life. Lift bars are rolled alloy steel, heat treated to obtain a hardness differential that will maintain lift height throughout life of the lining, thus providing maximum grinding efficiency. Each Lorain Lining is tailor-made to fit a particular mill. The linings fit snugly—shell wash is eliminated. Mr. A. E. Glasspool, Maintenance Supervisor at Hudson, said "Lorain Linings are designed right and they fit tight. Each piece was properly marked, so we had no trouble with installation."

These heavy-duty linings installed by Universal Atlas will provide effective grinding action without fear of broken bolts, cracked plates or bars, and will continue to perform efficiently until the plates wear paper-thin.

WE'RE GLAD TO HELP—If you are not aware of the merits of USS Lorain Rolled Plate Linings and are not using them—if you are experiencing lining difficulties of any nature, we will be glad to have a sales representative call on you. Just write to: United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

This 10′-6″ x 12′ Preliminator mill in Universal Atlas Cement's Hudson, New York, plant has ground 37,873,000 bbls. of clinker at a rate of 360 bbls. per hour.



The specially designed bolts will hold the Lorain Lining snug and tight for the life of the lining without fear of breaking. Lorain Linings are made of tough, rolled steel that is tailor-made to accurate shapes.

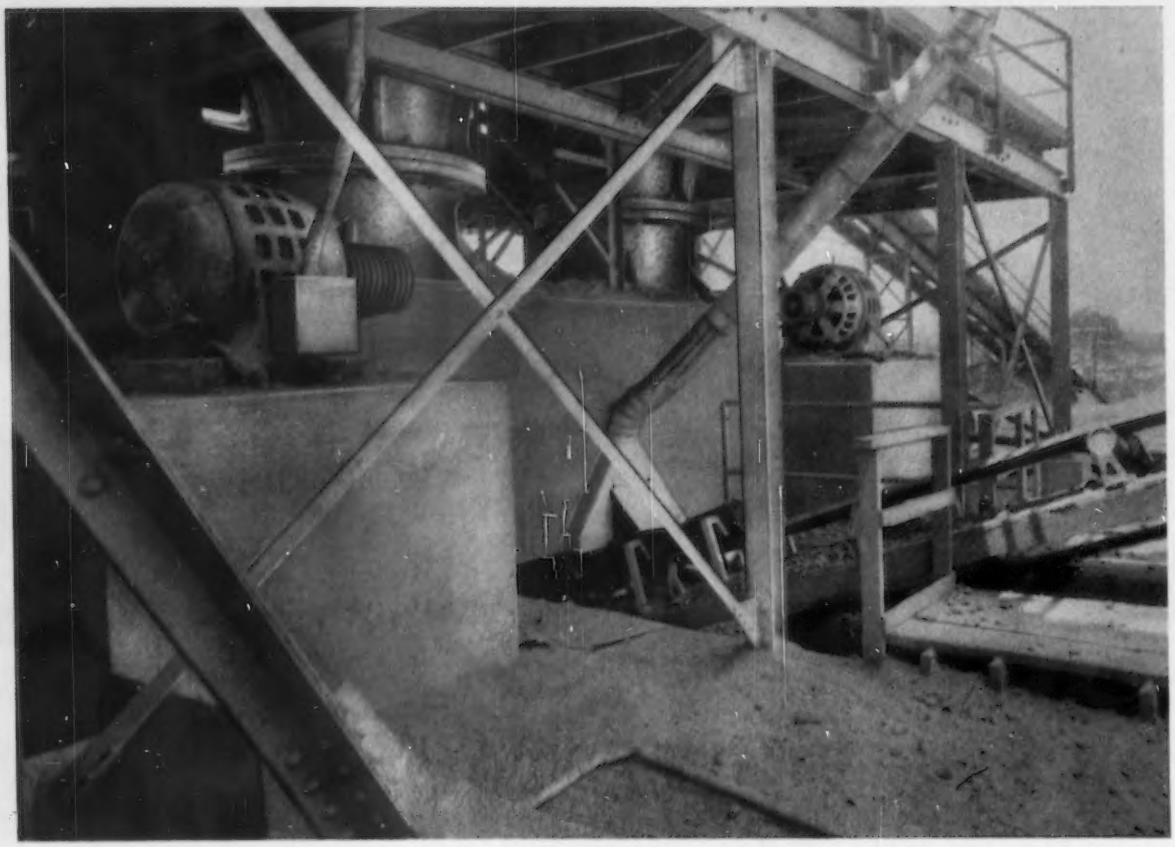
Although there was still some life left in the old lining, management decided to install the heaviest-duty Lorain Rolled Plate Lining for even greater grinding efficiency, and to assure continuous operation for several years to come.

These new, heavy-duty lift bars, Section M-4497, and 2-inch-thick liner plates are expected to increase mill efficiency. This lining will retain lift for millions of tons. USS Lorain Rolled Plate Lining successfully grinds until plates are worn paper-thin. USS Lorain-designed special manholes and covers were also an unusual feature of this installation.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS LORAIN ROLLED PLATE LININGS *and* USS GRINDING BALLS

UNITED STATES STEEL USS



Lower your ore reduction costs WITH THE HIGHER EFFICIENCY OF

Traylor TY

REDUCTION CRUSHERS

When you're faced with the problems of boosting daily tonnage figures and lowering production costs at the same time, you'll find the solution in a Traylor TY . . . the same as more than 806 operators on all types of secondary crushing installations throughout the world.

This proven production ability of the TY is due mainly to the unique design of its self-tightening bell head and Traylor curved concaves. Both these outstanding design features were developed as the result of more than a half century of Traylor engineering experience in this highly specialized field.

Traylor original curved crushing surfaces apply power as a direct crushing force. Traylor curved concaves working in combination with the Traylor bell head reduce lifting and churning of material in the crushing chamber.

Get all the facts on Traylor TY Gyratory Crushers . . . send for your copy of Traylor Bulletin #8112 describing all the features of the TY which can lead you to more profitable ore reduction.

TRAYLOR ENGINEERING & MANUFACTURING CO.
818 MILL ST., ALLENTOWN, PA.

SALES OFFICES: New York • Chicago • San Francisco
CANADIAN MFR: Canadian Vickers, Ltd., Montreal, P. Q.

5 "Euc" REAR-DUMPS

10 to 50 Ton Capacities

for CONSTRUCTION, MINE, QUARRY and INDUSTRIAL WORK

10-Ton

Model UD has 128 h.p. engine . . . 10-speed transmission . . . 36 m.p.h. loaded travel speed . . . spring mounted drive axle with 12.00 x 24 duals.

Euclid Rear-Dump hauling units for off-highway service are available in five sizes with capacities of 10, 15, 22, 34 and 50 tons. They have diesel engines of 128 to 600 total horsepower.

The simple rugged construction of "Eucs" pays off in long life and low maintenance cost. You get more work-ability because there's less down time for repairs. There are more Rear-Dump "Eucs" in service than all other makes of off-highway haulers combined.

Have your Euclid Dealer give you facts and figures on the complete line of Rear-Dumps and other Euclid equipment . . . you may find, as hundreds of owners have found, that ***Euclids are your best investment.***

EUCLID DIVISION, GENERAL MOTORS, Cleveland 17, Ohio

15-Ton

There are two 15-Ton models with 5-speed transmission and 14.00 x 24 tires. Model FD has 165 h.p. engine, and 10 cu. yd. body. Model R-15 has 218 h.p. engine, spring mounted drive axle, power steering and 10½ cu. yd. body. Quarry body is available for either model.

22-Ton

Model TD "Euc" is equipped with 300 h.p. engine, spring mounted drive axle with 18.00 x 25 duals, power steering and 15 yd. body. Available with Torqmatic Drive or 10-speed transmission. Standard or quarry body is available.

34-Ton

Model FFD has two engines providing a total of 400 or 436 h.p. to tandem drive axles through separate Torqmatic Drives. Dual tires are 16.00 x 25. Exhaust heated body has 24-yd. capacity.

50-Ton

Similar in design to the Model FFD "Euc", the 50-ton Twin-Power Model LLD has a total of 600 h.p. and an exhaust heated body with 32-yd. capacity. Tires are 18.00 x 33.

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE

EUCLID

At the turn of a dial, the furnace operator can set the required total Btu input for a multiple-fuel open hearth furnace.

Honeywell Metered Fuel-Air Ratio Control *Saves Fuel Dollars*

Fully automatic systems cut costs on single, alternate, or combined fuel-fired installations.

HONEYWELL metered fuel-air ratio control systems on your furnaces will get the maximum Btu's from available fuel. Moreover, in addition to saving fuel dollars, these systems are designed for operating convenience.

For example, an operator can check firing conditions by merely glancing at the large, easily-read charts and scales on the *ElectroniK* controllers. With the turn of a knob, he can set up automatic Btu input control, or switch over to manual control for startup or emergency operation.

Honeywell metered fuel-air ratio control systems are, fundamentally, fuel savers, and are applicable to gas, oil, tar, pitch, air, or steam flow measurement and control. They provide direct and immediate indication of set points and ratio settings. Where panel space is limited or where graphic centralized panel operation is desirable, Honeywell miniature *Tel-O-Set* instruments can be supplied in these systems.

Each system is individually engineered to your specific furnace and fuel requirements. For a discussion of what Honeywell metered fuel-air ratio systems can do for you, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● REFERENCE DATA: Write for Data Sheets No. 4.3-4a, "Fuel-Air Ratio Control Systems"—and No. 6.4-12, "*ElectroniK* Inductance Bridge Receivers."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Why Thermoid Hose Lasts Longer

Mine operators everywhere find Thermoid Hose stays on the job longer—cuts replacement costs and down time. One big reason is quality construction. Another: Thermoid designs hose for specific conditions and uses. Here are three examples:

THERMINE — High pressure air hose. Oil resistant tube is reinforced by heavy duty yarn. Mandrel-built for precision construction and greater strength. Smooth, abrasion resistant cover.

#325 S B. SUCTION — Heavy duty hose for water suction service. Smooth bore, wrapped hose with heavy wire reinforcement, durable duck plies.

#300 AIR HOSE — Wrapped construction, oil resistant synthetic tube and covers. Heavy duck reinforcing plies. Ideal for use in mines and quarries.

These are typical examples of how Thermoid Personalized Service meets the specific, exacting requirements of the mining industry.

Thermoid

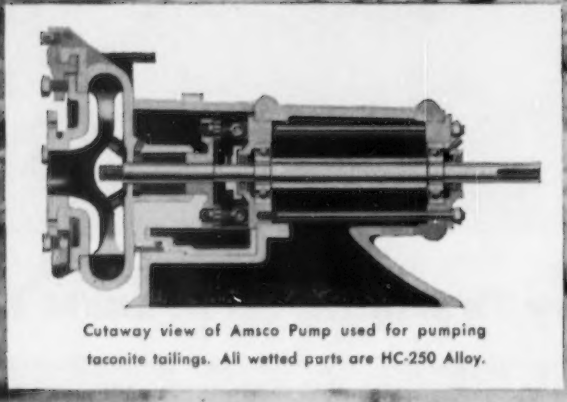
Thermoid Company
Trenton, N. J.

Make Thermoid your choice, too for Multi-V Belts . . .

. . . and Conveyor Belting, specifically designed for the job.

Your Thermoid Distributor can help you select the Hose, Conveyor Belting, Multi-V Belts designed to lower your operating costs.

Handling TOUGH taconite tailings



Cutaway view of Amsco Pump used for pumping taconite tailings. All wetted parts are HC-250 Alloy.

AMSCO® HC-250 Alloy outlasts previous material 4 to 1

On the Iron Range at a Minnesota plant handling taconite tailings, a 6″ Amsco Pump was equipped with complete HC-250 water ends and HC-250 impeller.

In this highly abrasive pumping application, the HC-250 water ends have given over 4,500 wear-hours. The impeller is outlasting the previous alloy material 4 to 1.

HC-250 is a special, high-chromium alloy perfected for pump parts in operations where highly abrasive material is being moved. This alloy is not limited to purely abrasive problems; it also has excellent resistance to rust, corrosion and impact.

To get extra efficiency from your pumping operations, ask your Amsco Pump specialist for data on HC-250. He will analyze your requirements and recommend the type of Amsco Pump—and material for wear-parts—best suited for your application.

AMERICAN Brake Shoe COMPANY

AMSCO

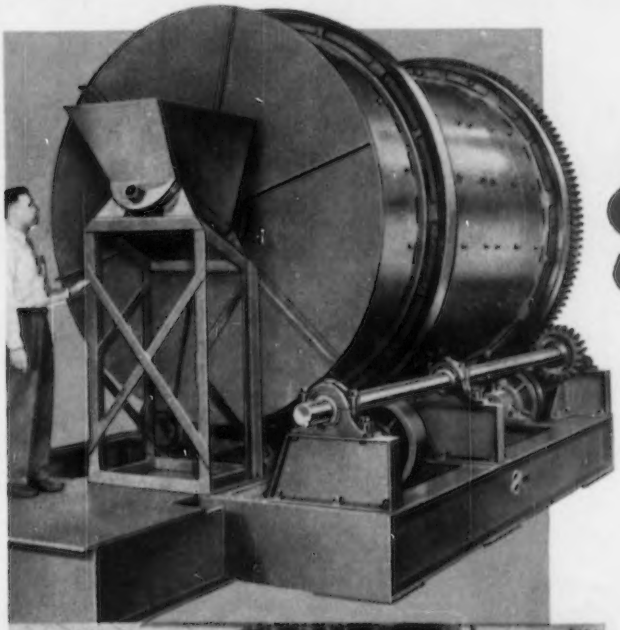
American Manganese Steel Division • Chicago Heights, Ill.

OTHER PLANTS IN: DENVER, LOS ANGELES, NEW CASTLE, DEL., OAKLAND, CAL., ST. LOUIS; JOLIETTE, QUEBEC

FOR CLEAN ORE—HIGH CAPACITY

TELSMITH®

Super-Scrubbers®



Philippine Islands—this mill of **Baguio Gold Mining Company** is equipped with a 60-inch Telsmith Super Scrubber.

Minnesota—in the custom mill of **Skubic Bros.**, Virginia, Minn., a 96-inch Telsmith Super Scrubber turns out remarkably clean ore at minimum cost.

● **high speed...terrific impact...grinding action much like a ball mill.** Ore travels from feed to discharge end against clean water flowing in the opposite direction —emerges clean—with clay and dirt disintegrated and carried away by the water.

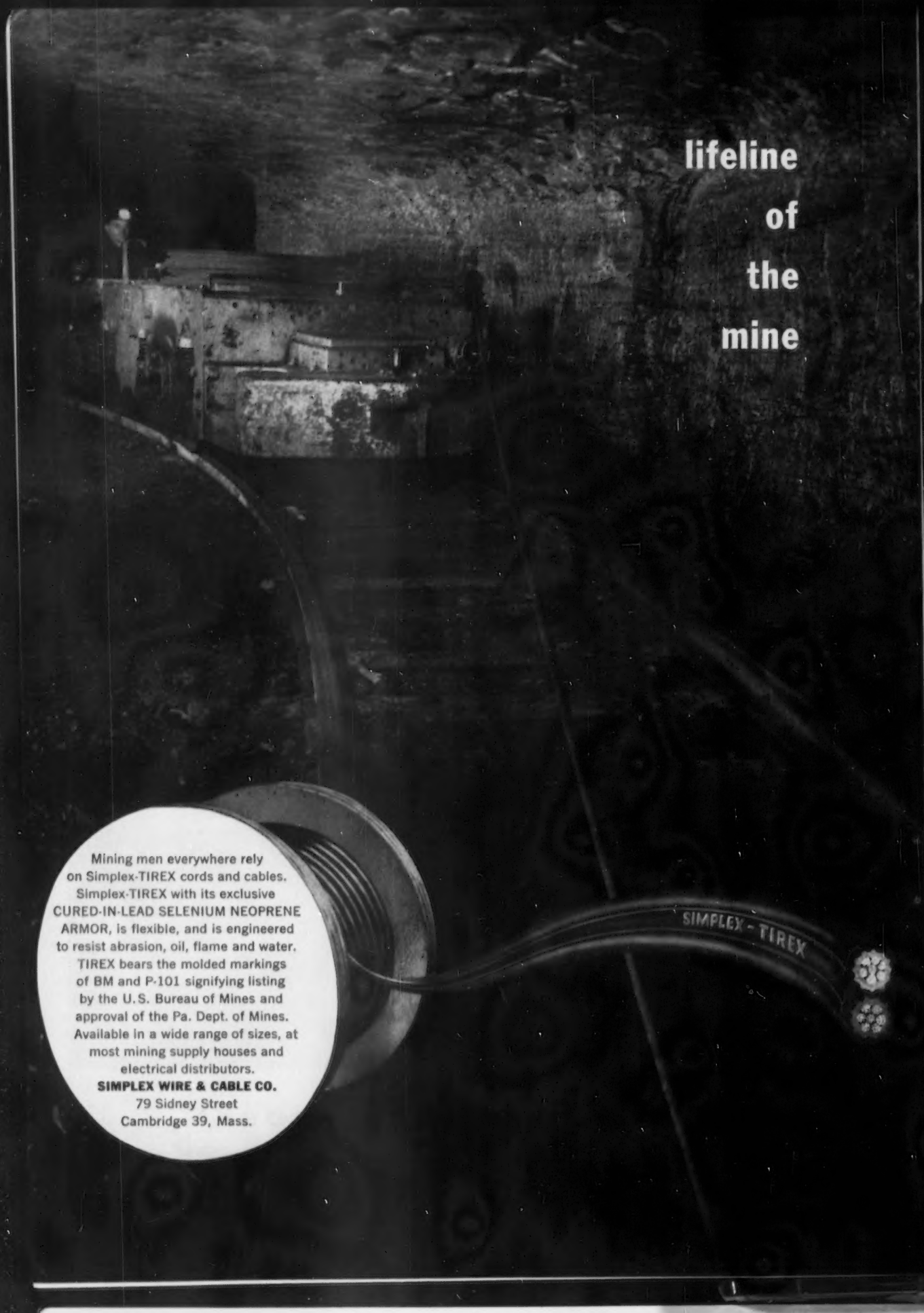
low cost installation, operation and up-keep. Economical of water and power. The Telsmith Super-Scrubber is made in four sizes: 60-inch to 96-inch; with capacities of 50 to 250 tons per hour. Send for descriptive Bulletin 266.

Min. 38

SMITH ENGINEERING WORKS

502 E. CAPITOL DRIVE **MILWAUKEE 1, WISCONSIN**

Representatives in Principal Cities in All Parts of the World • Cable Address: Sengworks, Milwaukee



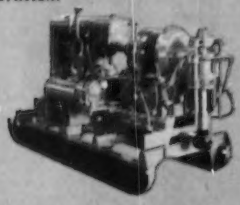
Mining men everywhere rely on Simplex-TIREX cords and cables. Simplex-TIREX with its exclusive CURED-IN-LEAD SELENIUM NEOPRENE ARMOR, is flexible, and is engineered to resist abrasion, oil, flame and water. TIREX bears the molded markings of BM and P-101 signifying listing by the U.S. Bureau of Mines and approval of the Pa. Dept. of Mines. Available in a wide range of sizes, at most mining supply houses and electrical distributors.

SIMPLEX WIRE & CABLE CO.
79 Sidney Street
Cambridge 39, Mass.

When you're CORE-DRILLING, it's no gamble with these 3 aces in the hole

22-HD *The rugged, heavy-duty model. Single-line capacity—2,250' with AWX fittings. Also available as truck-mounted drill or on twin-column mount for underground operation.*

1

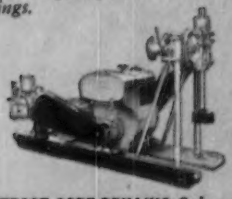


12-B Extremely portable, weighs approximately 1200 lbs. Capacity—1,250' with EWX fittings. Also available on twin-column mount with air motor drive for underground operation.

2

No. 7 The lightweight, easily transportable model. Can be taken underground or transported by airplane, boat, or even muleback into remote areas. Capacity—500' with EWX fittings.

3



CONTRACT CORE DRILLING *Sub-surface test borings for mineral prospecting, foundation drilling, and grout hole drilling are available on a contract basis. Highly skilled crews and complete stock of core drills, bits, and accessory equipment are maintained at all times.*

JOY Diamond Core Drills When these three "aces" go into the holes, luck no longer is a factor. They are a sure bet to tell you exactly what is down there. And, at Joy, you can find the right "ace" to do the best job for you.

With capacities ranging from 500 to 4000 feet (the 22-HD, with larger power unit and using multiple lines, has drilled to depths greater than 4300') there are Joy diamond drills applicable to almost any coring job. And they'll do the best job for you. Here's why . . .

EXTREME PORTABILITY Skid mountings, compact design, and rugged construction make it possible to drag Joy diamond drills into some of the most inaccessible locations.

VERSATILITY Because they are available with either hydraulic or screw-feed swivelheads and with a choice of gasoline, electric or air power, Joy core drills can fit into any drilling program without expensive preparations.

Check your drilling needs against this group of outstanding drills. One of them will be suitable to your needs and it will do an accurate, economical job of proving the mineral value of your property. Write today for literature on the machine you need to ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

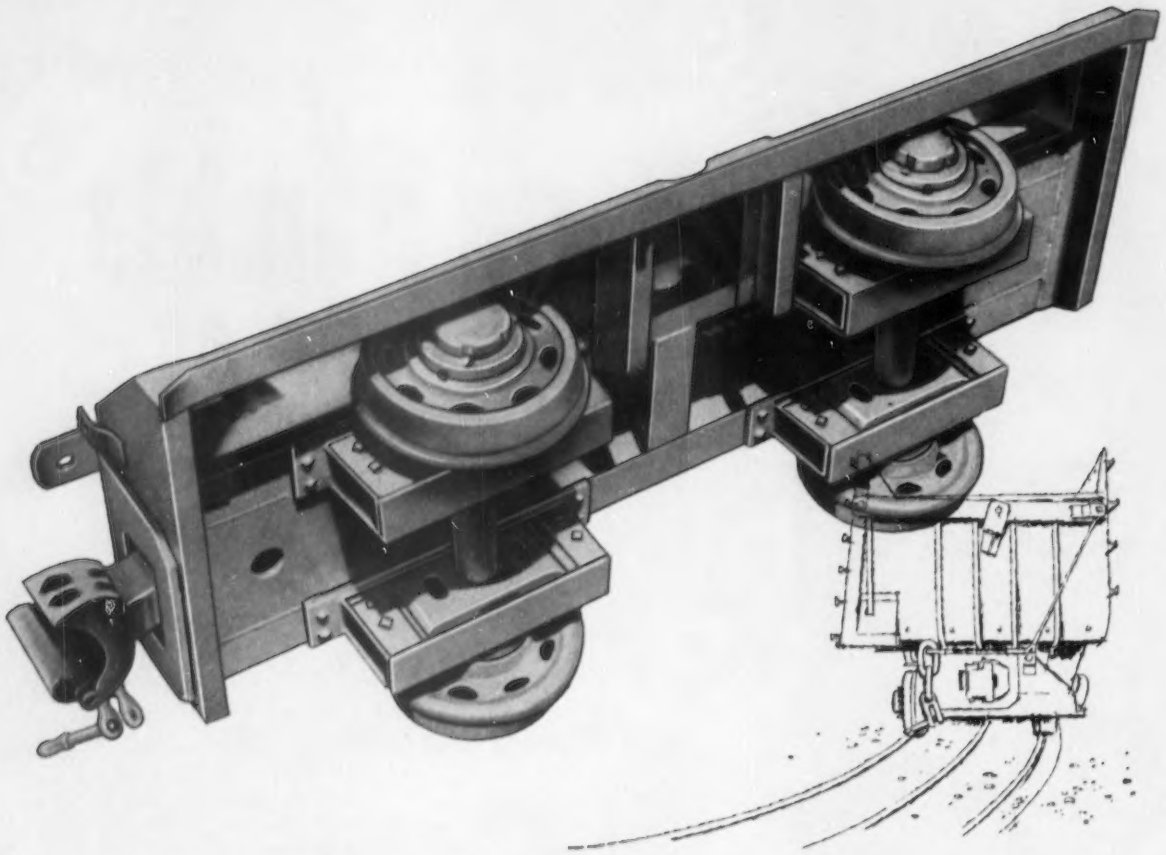
Write for FREE Bulletin 86-4

JOY

WORLD'S LARGEST MANUFACTURER OF CORE DRILLS AND MOTORIZED DRILL RIGS SINCE 1851

Consult a Joy Engineer

WSW M5508-86



for extra strength
it's CRUCIBLE **MAX-EL** alloy steel

Mine car axles *always* take a beating. But where service is *especially* rugged, manufacturers – like C. S. Card Iron Works, Denver, Colorado – use Crucible Max-el 3½ alloy steel. In their own words, here's why . . .

"We use Max-el 3½ because of its high-strength . . . good fatigue resistance . . . and over-all economy."

Good reasons why Max-el, or another of Crucible's wide range of special alloy steels, may be the right answer to many of your more exacting applications. Your local Crucible representative will be glad to give you more details.

Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

E&MJ NEW PRODUCTS DIGEST

LLOYD E. ANTONIDES, Assistant Editor

Magnetometer (1) ►

Permanently mounted orienting compass and 13-lb weight (including tripod) make Sharpe A-2 Vertical Force magnetometer a one man instrument, says Geophysical Instrument & Supply Co., Denver, exclusive dealer in U. S.

◄ Theodolite (2)

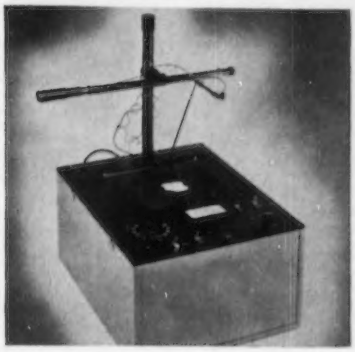
Fitting in 3x8-in. container and weighing 7 lb (with tripod), T-12 is 1-min "pocket" Theodolite. Maker is Wild Heerbrugg Instruments Inc., Port Washington, N.Y. View through window is refracted up to eye-piece by prism.

E. M. Surveying Unit (3)

Claimed inexpensive and attracting attention of "mining experts," electromagnetic unit for detecting conductive orebodies runs on dry cells, weighs 13 lb, and comes in two carrying cases. K. Jackson, Kalamunda, Australia, offers it.

Seismic Recorder (4)

Recording oscillograph camera, RS-80, is designed for operation with all-frequency seismic techniques and for recording magnetic playback. It is product of Houston Technical Laboratories, Houston, Texas.



Airplane Tires (5)

Small Terra-Tires have been adapted for light planes operating off rough strips. Goodyear Tire & Rubber Co., Akron, Ohio, makes the barrel-shaped, low-pressure balloons with integral axle hubs. See June's NPD Item No. 14.

Altimeter (8)

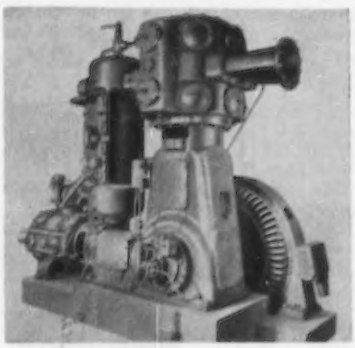
Fast acting, highly sensitive (1 ft at sea level) aneroid barometer has been developed for aircraft altitude control by Garrett Corp., Los Angeles. Application to visual altimeters is said to be promising.

Gravity Survey Unit (7)

Anomaly simulator by Houston Technical Laboratories, Houston, Texas, aids interpreting gravity surveys. Using a light source, two dimensional silhouettes and photo cell on arm, it gives shape of orebody from field data.

Hole Logging Unit (9)

Tightly sealed against dust and water, radio-active logging apparatus, GHL-230, for drill holes is offered by Mount Sopris Instrument Corp., Boulder, Colo. It uses Gieger tube probe and is easily portable in two packages.



Airleg Diamond Drill (10)

For a compact, fast set-up, this one-man diamond drill unit is offered by Canadian Longyear Ltd., North Bay, Ontario. It weighs 80 lb and is rated at 60 ft of 1½-in. O.D. hole ($1^{5}/_{16}$-in. core). It is powered by 12-hp air motor.

Air Compressor (11)

Models of AR series of air compressors from Atlas Copco Pacific Inc., San Carlos, Calif., range from 330 to 3220 cfm. Low operating speeds are claimed as feature. Smaller units can be skid mounted but larger ones are stationary.

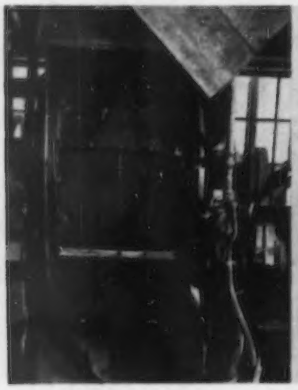
Air Leg (12)

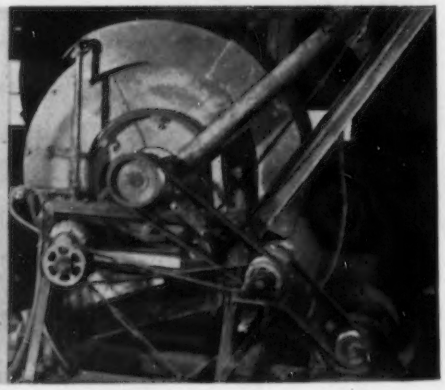
"Short Leg", shown extended, is suggested as solution to any drilling in close quarters. Specifically designed by Junction Bit & Tool Co., Grand Junction, Colo., to start drift from 36-in. vent shaft, it fits sinker drills.

Continued On Page 36. For More Information On These Items, Use Card Opposite Page 42.

Jaw Crusher (13)

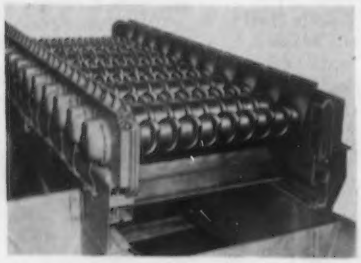
Among world's largest overhead eccentric jaw crushers is WRB, with 44x48-in. feed opening, made by Universal Engineering Corp., Cedar Rapids, Iowa. Capacity at 4-in. discharge opening is 200-350 tph; at 12-in., 800-950 tph.





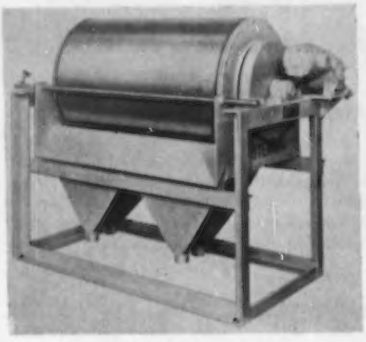
Impact Crusher (14)

Cully Ore Disintegrator Co. Ltd., Eugene, Ore., offers an impact type crusher called Whirlwind. Among claims for secondary crusher are: it is self-classifying, self-cleaning, non-clogging and non-sliming. Model shown has capacity of 1 ton per hour of minus 1½-in. feed with 20 mesh discharge screens. High solids pulp is fed through inlined pipe to center rotor. Drum, with screen discharge openings, revolves and recirculates oversize. Stationary water guard covers right side.



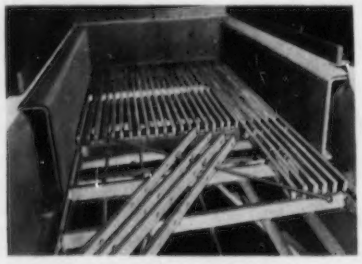
Grizzly-Feeder (15)

"Wobbler" is heavy-duty feeder-scalper by Universal Engineering Corp., Cedar Rapids, Iowa. Self-cleaning, tumbling action of oval bars reputedly cuts vibration and headroom. Choke loaded unit can be set to ¾ in.



Heavy Media Aid (16)

Wet drum magnetic separator, WPD, by Stearns Magnetic Inc., Milwaukee, Wis., is designed to recover media in heavy density plants. Permanent Alnico magnets are used—eliminating rectifier or motor-generator set. Permanent Alnicos are replacing energized separators in many magnetic flowsheets.



Clinker Cooler Grate (17)

"L" shaped elements now form rigid heat resistant surface of feed end grate for air-quenching clinker cooler by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Used on hot material from rotary kilns. Thru-bolts make "clinching-up" easy.

Bin Vibrator (18)

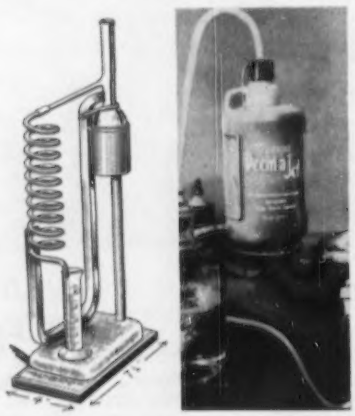
Small, 25-lb electric bin vibrator is announced by Cleveland Vibrator Co., Cleveland, Ohio. Portable or permanent RC-5 is silent, gives 275-lb impact and is meant for hoppers, chutes, et al, where duty does not require large unit.

Liquid Level Control (19)

Where liquid level must be maintained with close accuracy (± 5/32 in.) or is shallow (⅜ in.), No. 140 electric control unit is recommended by Henry G. Dietz Co., Long Island City, N.Y. Air trapped in inverted cup acts on diaphragm switch.

Distilling Unit (20) ►

Compact, and quick operating and to set-up, are features claimed for lab distilling unit, CW-656, from Cargille Scientific Inc., New York, N.Y. Cup-like electric heater holds standard 25 ml distilling flask. Carrying case is optional.



◄ Water Demineralizer (21)

Portable Deemajet 128 ion exchange water demineralizer instantly delivers 1 gal per min., uses replaceable resins and is made of polyethylene, says Crystal Research Laboratories Inc., Hartford, Conn. Capacity is 1750 grains as NaCl.

Vibration Detector (22)

Electric Vibraswitch is designed to shut down rotating equipment before malfunctions cause damage, by detecting slight increase in vibration. Beta Corp., Richmond, Va., says some applications are vent fans, MG sets, et al.

Noise Analyzer (23)

Noise abatement programs will be aided by Soundscope, says Mine Safety Appliances Co., Pittsburgh, Pa. Self-contained, 20-lb electronic unit replaces four units formerly needed to properly analyze intensity and frequency, it is said.

Continued On Page 38. For More Information On These Items, Use Card Opposite Page 42.

Protection
Under ALL CONDITIONS of Grinding Operation

▶ Protection requirements vary. That's why Allis-Chalmers control is recommended and applied with expert, personal attention to the specific problem at hand. For example, the starter illustrated is custom-engineered to control a 1000-hp, 2300-volt synchronous motor driving a ball mill. Its protection features not only meet regular operating requirements but also handle unusual emergency conditions. These features include:

- **Current-Limiting Fuses**
- **Thermal Overload Relays**
- **Squirrel-Cage Protective Relay**
- **Time-Delay Undervoltage Relay**
- **Polarized Field Application Relay**

For complete information, see your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4703

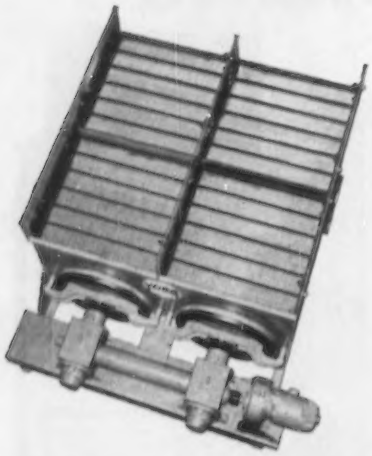
Optional Features:

Exciter voltage relay to prevent starting when excitation voltage is not available; dc field failure relay to shut down motor on field current failure; instantaneous phase reversal and open phase; inching control for positioning mill.

A-C ALLIS-CHALMERS

YUBA JIGS

for mills and dredges



Handle any material that can be concentrated, such as

CASSITERITE	RUTILE
GOLD	SCHEELITE
PLATINUM, ETC.	GARNETS
MONAZITE	SAPPHIRES
ZIRCONIUM	IRON
ILMENITE	COPPER

YUBA jig action is positive. Just set to desired speed and stroke, get constant uniform pulsations that create surface action over full area of jig bed. Result: YUBA M-8 jigs have large material capacity per flow line under full control.

Stroke adjustments between ¼" minimum and 3" maximum are easily and quickly made. Maximum frequency of a 4 cell M-8 jig is 350 at ¼".

YUBA jig design saves space, increases production in new or old dredges or mills. Use to supplement existing jigs or replace other concentration methods. For details of adapting YUBA jigs to your operation, send us data on ore, feed sizes and present installation.

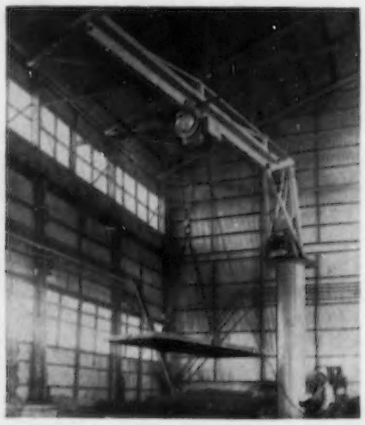
75

YUBA MANUFACTURING CO.
Room 600 • 351 California St. • San Francisco 4, Calif.

E&MJ NEW PRODUCTS DIGEST *(Continued)*

Lift Platform (24)

Hydraulic-elevating work platform can raise 1250 lb from 5-ft height to 15 ft. Ballymore Co., Wayne, Pa., offers hand-pump or electric battery or plug-in powered units. Ladder telescopes and 33-x162-in. floor can hold three men.



Jib Crane (25)

Power-rotated, 6- to 15-ton jib cranes have been introduced by R. G. LeTourneau Inc., Longview, Texas. Designed for heavy-duty, one-man handling, electric powered unit has "fraction-of-inch" controls, it is said. All have 25-ft boom.

Crane Travel Motor (26)

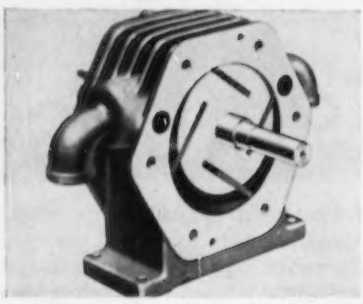
For smaller bridge and trolley cranes, brake-motor with built-in mechanical brake is claimed to insure smooth and gentle operation. It is made by Cleveland Electric Motor Co., Cleveland, Ohio. Braking torque is adjustable.

Crane Hoist Motor (27)

Eddy current braking on electric monorail type hoist, claimed industry's first, will find greatest use where exceedingly gentle hoisting and lowering is essential, says Yale & Towne Mfg. Co., Philadelphia, Pa.

Carloader Belt (28)

Thinner carloader (thrower or slinger) belts by Thermoid Co., Trenton, N. J., are designed to combat high speed and small pulley damage. Said to last longer, the endless belts come in three sizes in the special construction.



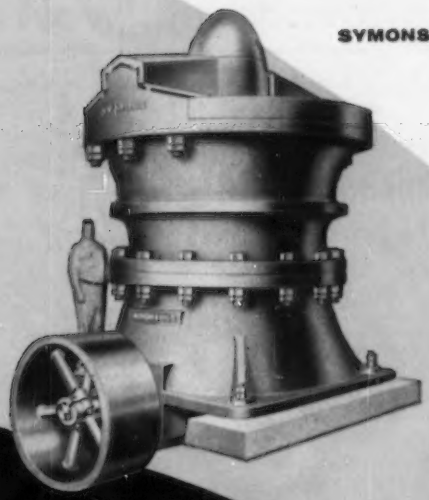
Gas Pump (29)

Vacuum and/or pressure rotary pumps for handling moist gases are made of corrosion-resistant bronze and have sintered carbon (Graphitar) vanes which need no lubrication. Dexter Folder Co., Pearl River, N.Y., is maker.

◄ Sump Pump (30)

Self-priming, Flygt submersible electric pumps can handle water with up to 40% solids. Distributor is Stanco Mfg. & Sales Inc., Los Angeles, Calif. Small, 70-lb unit, B-38L, can handle 25 gpm at 60-ft head or 55 gpm at 20 ft. B-80 can be carried by two men, is powered by 6-hp motor and has pumping range of 110 gpm at 90 ft to 275 gpm at 20 ft. After emptying sump, pumps will start automatically when water re-enters.

Continued On Page 40. For Information On Items, Use Card Opposite Page 42.



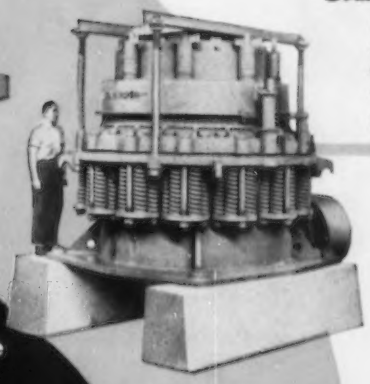
SYMONS® PRIMARY GYRATORY CRUSHERS

Built in 30", 42", 54", 60" and 72" sizes, for capacities up to 3500 or more tons per hour.

NORDBERG MACHINERY

for URANIUM PRODUCTION

keeps pace with the Atomic Age



SYMONS CONE CRUSHERS

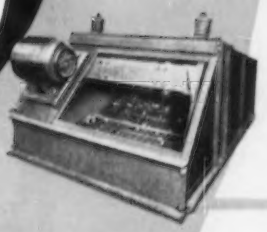
Built in both Standard and Short Head types, in sizes from 22" to 7', in capacities from 6 to 900 or more tons per hour.

URANIUM—the Wonder Metal of the Atomic Age—is today one of the most sought after elements in the earth's crust. And with good reason when you consider that one pound of pure Uranium will produce by fission as much energy as the combustion of 20,000,000 pounds of coal. This powerful new servant serves mankind in many ways and each day its benefits grow increasingly greater.

Increasing too is the role being played by Nordberg Machinery in the efficient processing required for production of this valuable metal. From the Congo and South Africa to the ore bodies of the United States and Canada, leading producers are installing Symons Gyratory Crushers for primary breaking, Symons Cone Crushers for finer reduction, Symons Grizzlies and Screens for scalping and sizing, and Nordberg engines for mine and mill power.

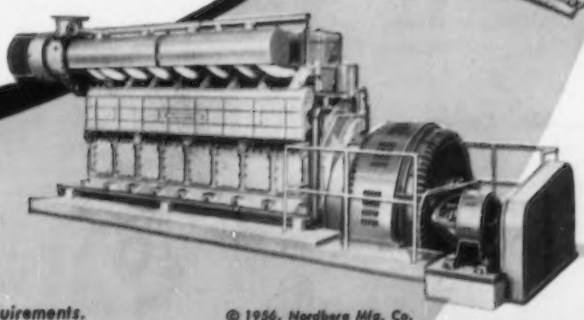
SYMONS VIBRATING BAR GRIZZLIES

Built for heavy duty large capacity scalping service. Particularly effective when handling wet, sticky or gummy ores. Will handle feeds up to 30" and larger.



SYMONS ROD DECK SCREENS

Highly efficient, big capacity units adaptable to mill feed screening and for handling heavy feeds of wet, sticky ores.



NORDBERG ENGINES

Built in a wide range of sizes from 10 to over 12,000 horsepower, including Diesel, Duafuel® and Spark-Ignition Gas types for low cost power generation.

Write for information on your machinery requirements.

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NORDBERG MFG. CO.
Milwaukee, Wisconsin

SYMONS . . . A Registered Nordberg Trademark known throughout the world.

NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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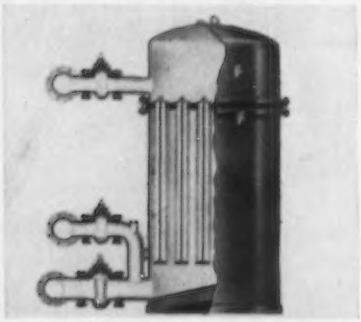
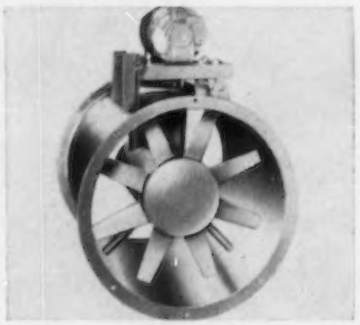


Liquid Filter (31)

On IWF industrial filter by R. P. Adams Co. Inc., Buffalo, N.Y., air trapped in dome forces liquid back through pores of filter elements at high velocity, purging foreign matter and eliminating disassembly for cleaning.

Dust Collector (32)

Vane design of Cyclo-trell produces higher gas flow than previously obtained with multiple tube centrifugal dust collectors, according to Research-Cottrell Inc., Bound Brook, N.J. Collection efficiency is boosted too, it is said.



Fan (33)

Higher pressure characteristics and less operating noise are features of BD axial flow fans, says Detroit Blower Corp., Franklin Park, Ill. Belt driven units have extra wide blades and design gives more even hub-to-tip flow.

Air Filter Element (34)

Electrostatic plastic materials are used in heavy-duty Pliotron dust filter by Goodyear Tire & Rubber Co., Akron, Ohio. Immersing it in warm water causes dirt to drop out since static charge is temporarily lost.

Moisture Proofing (35)

Extension spray hose and nozzle for aerosol "bomb" aids application of Safe-T-Seal electrical moisture proofing compound in hard-to-reach places. Complete dispenser is available from MB Aircraft Services Inc., Burbank, Calif.

Air Sampler (36)

Fixt-Flo is compact air sampler designed to collect large samples of airborne contaminants on filters for analysis. Mine Safety Appliances Co., Pittsburgh, Pa., says automatic flow control as filter loads-up keeps volume exact.

Lining (37)

For high abrasion and corrosion resistant coverings, Bondable Teflon sheets and tapes now have surface treated to permit bonding with commercial adhesives to a variety of materials. It is made by Flexrock Co., Philadelphia, Pa.

Power Tool (39)

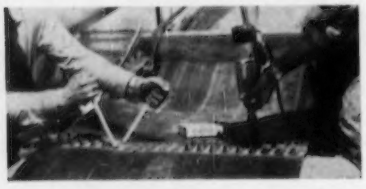
Designed to cut smooth, perfect holes in wood, plastic or metal, Hole Saw is handy tool for electricians, plumbers and carpenters. Made by Alladin Mfg. Co., Kansas City, Mo., it adds to their line of ¼-in. electric drill attachments.

Pipe Bender (40)

Hydraulic pipe bender, RC 200, can make any degree bend in one setting, says the Tal Co., Milwaukee, Wis. Removable top plate permits sliding on or hooking over ½- to 2-in. pipe, conduit or tubing in almost any position, it is said.

Rust Remover (38)

Development of an alkaline material for removal of rust, paint and primer in one easy dip and rinse has been announced by Turco Products Inc., Los Angeles, Calif. It is reported not to contain cyanide nor to emit corrosive fumes.



Belt Fasteners (41)

Faster method of splicing conveyor belts with Flexco fasteners, templets and power tool attachments is announced by Flexible Steel Lacing Co., Chicago, Ill. Templet guides boring bit, then holds bolts while belt is placed on them.

Weighing System (42)

Magnetic air gap transducer measures deflection of steel bending member within load cell on scale system of Ball Brothers Co. Inc., Muncie, Ind. Small electronic unit lends itself to portable applications. Overloads do no harm.

Conveyor Scale (43)

Compact "H" Weightometer by Merrick Scale Mfg. Co., Passaic, N.J., is automatic conveyor scale claimed to be very sensitive to load variation, to have "no-creep" zero balance, and to be designed for continuous heavy duty.

Weighing System (44)

Hydraulic "transducer" converts force (or weight) into hydraulic pressure on EC weighing system of A. H. Emery Co., New Canaan, Conn. It is claimed ideal under rugged and adverse conditions, and lends itself to remote controls.

Dragline Buckets (45)

Lighter weight dragline buckets, with solid or perforated baskets, are offered by Bucyrus-Erie Co., South Milwaukee, Wis. BL type is for material like loose gravel or clay; BM for light shale or cemented gravel; BH for heavy duty.

Clamshell Buckets (46)

Two groups—⅜- to 4-yd light Rehandlers and ⅜- to 2-yd extra heavy-duty Hard Diggers—have been added to line of clamshell buckets of Erie Strayer Co., Erie, Pa. Complete line can be adapted to 3- or 4-line use.

Bulldozer Attachments (47)

Caterpillar Tractor Co., Peoria, Ill. announces two bulldozer attachments. Hydraulic tilting cylinders to replace left blade brace on 8S and 9S bulldozers; and angling blades for use with 933, 955 and 977 Traxcavator front-end loaders.

Continued Opposite Page 42. For More Information On These Items, Use Card Opposite Page 42.

Now! Set underground survey spads without interrupting mining crews!

NEW THOR AIR HAMMER

2-inch drilling depth in rock in seconds!

Swivel hose connection
Free swiveling air connection keeps hose from kinking.
Easy lubrication
Oversize oil reservoir can be filled without using a wrench.
Thor exclusive stop rotation
Instant conversion with the flick of this handy cam lever.
Weight only
14
LBS.

Speeds work of survey crew in tunnel and mining operations ... saves its cost in days

Here's how the new Thor Model 15 Air Hammer makes quick work of drilling overhead to save time for survey crews.

INSTEAD of tying up a mining crew for hours while a survey crew drills survey spad holes every few feet, give the survey crew its own light-weight, fast-action Thor Air Hammer. With this Thor Model 15, a 50-ft. length of ¼" air hose, and a ⅝" tungsten-carbide bit, your survey crew is fully equipped to drill its own holes.

This Thor Air Hammer's exclusive stop-rotation feature gives it many other uses, too. Ask your Thor distributor for a demonstration. Thor Power Tool Co.

Thor
PORTABLE POWER TOOLS

THOR POWER TOOL COMPANY
Aurora, Illinois

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Use Cincinnati Air Hose

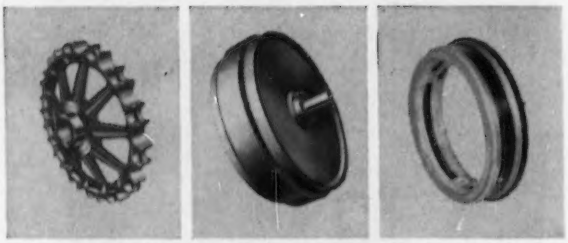
Anybody ever tell you there's no difference in parts?

Take sprockets, for example. Caterpillar *original* sprockets feature *deep-hardened teeth* with tough cores to withstand shock loads. CAT* original idlers have steel disc construction, with steel treads *flame-hardened* for greater wear. Cat bellows seals are of self-aligning face-type design. They help keep lubricant in and dirt out, even on the dustiest job. You're *sure* of new machine performance with original parts like these.

With substitute parts, can you be sure of anything?

Better see your Caterpillar Dealer's Parts Representative—and get Cat original parts every time.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.



Caterpillar sprockets, idlers and seals are the result of over 50 years of track-type tractor manufacture. So don't be fooled — there is a difference in parts. Why take chances with substitutes?

CATERPILLAR*

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E&MJ NEW PRODUCTS DIGEST *(Continued)*

BEARINGS and other load joints faced with fabric of Teflon show promise in eliminating need for conventional lubrication, according to DuPont release. Developer is American Metal Products Co., Detroit. **(48)**

WIRE ROPE with flattened strands—already 10% stronger than round strand of same size—is now made another 15% stronger by use of extra high strength steel and steel core, says Leschen Wire Rope, St. Louis, Mo. **(49)**

MAGNETIC SHIELDING alloy steels —Netic and Co-Netic—for protecting instruments, parts, recordings, et al., from magnetic damage, have been developed by Perfection Mica Co., Chicago, Ill. Test kit is available. **(50)**

SHELVING made of steel rod is development of Metropolitan Wire Goods Corp., Brooklyn, N.Y. Claimed to have high load capacity, Erecta-Shelf is set up without use of any tools and requires no bolts, nuts or screws. **(51)**

PUNCHED CARD systems have time-saver in adaptation of visual Kardex scheme, says Remington Rand Div., Sperry Rand Corp., New York, N.Y. Method involves housing and indexing edge-punched cards or short perforated tapes. **(52)**

BOLTS, called Hi-Psi super bolts, by Standard Pressed Steel Co., Jenkintown, Pa., are said to break through traditional strength limits of steel by whipping fatigue weakness that usually accompany high strength. **(53)**

WIRE ROPE CLIPS offered by American Chain & Cable Co. Inc., Wilkes-Barre, Pa., are hot dip galvanized after threading and base channel of high grade forging steel is designed to prevent damage to individual strands. **(54)**

FASTENING GUN called Mighty-Mite Model 456, is small, low-cost powder-actuated stud driver of Remington Arms Co. Inc., Bridgeport, Conn. It is designed for lighter work than Model 455. Hammer blow fires tool. **(55)**

TREAD PLATE with non-skid surface by Aluminum Co. of America, Pittsburgh, Pa., has aluminum oxide abrasive fused on one side of aluminum plate. It is claimed not to separate when welded and works covered with oil. **(56)**

RESPIRATORS in latest group offered by American Optical Co., Southbridge, Mass., are said to give protection against specific volatile mists and gases as well as dusts. Replaceable cartridge filters are used. **(57)**

For Your Files

This informative manufacturers' literature is free unless otherwise specified. To obtain bulletins circle their numbers on card at right and mail.

FILTER FACTS is title of new periodical covering case histories on different types of fluid, air and gas filter usage. It is issued by Dollinger Corp., Rochester, N.Y. **(60)**

TRUCK OPERATORS HANDBOOK by B.F. Goodrich Tire & Equipment Co., Akron, Ohio, is comprehensive 64-page manual on tires. Catalog section is included. **(61)**

DEMINERALIZATION is thoroughly treated in 24-page Technical Reprint T-140 issued by Graver Water Conditioning Co., New York, N.Y. It contains comprehensive bibliography. **(62)**

DREDGES available at low-cost from Yuba Consolidated Gold Fields, San Francisco, Calif., are described in folder. **(63)**

FLOTATION machine for laboratory is shown on one data sheet and solid rubber and rubber covered impellers for production machines are shown on another sheet from Booth Co., Salt Lake City, Utah. **(64)**

REFRACTORIES is bimonthly magazine of Carborundum Co., Perth Amboy, N.J. First issue (Feb '56) discussed heat conductivity; second, covered chemical resistance and stability. **(65)**

MINERAL FLOTATION with Cationic Chemicals is booklet by Chemical Div., Armour and Co., Chicago, Ill., giving concise presentation of subject. **(66)**

WELDING ELECTRODES for mild steel are cataloged in Weldirectory SB 1351 by Lincoln Electric Co., Cleveland, Ohio. But it is really more of an excellent welder's manual. **(67)**

SLUSHER BLOCKS, with Timken bearings, available from Skookum Co., Portland, Ore., are shown on new catalog page. **(68)**

MINING MACHINERY from Morse Bros. Machinery Co., Denver, Colo., may be used but it is claimed dependably reconditioned—58 years experience is guarantee. Current catalog is available. **(69)**

JULY 1956

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He's making a half-hitch for a fast ride . . .

He's connecting a "down" or branch line of Reinforced Primacord at right angles to his trunk line of Plain Primacord. He's using a double half-hitch, *drawn tight — because the detonating wave will take this switch at about* 4 *miles per second!*

This detonating wave is set up in the Primacord trunk line when it is detonated at one end with fuse and cap or electric blasting cap. It travels along the trunk and down to the bottom of each hole, where it initiates the detonation of every explosive in the charge. It's a pretty fast "ride" — but not too fast, because the millisecond interval between holes and rows of holes promotes relief of burden — better fragmentation — easier digging.

Remember, when you detonate with Primacord you can *fire when ready.* Because this detonating fuse is insensitive to sparks, friction, ordinary shock and stray electrical currents. Made in Plain, Reinforced, Plastic Reinforced and Plastic Wire Countered — each designed for a particular purpose.

Ask your Explosives Supplier, or write to **THE ENSIGN-BICKFORD COMPANY**

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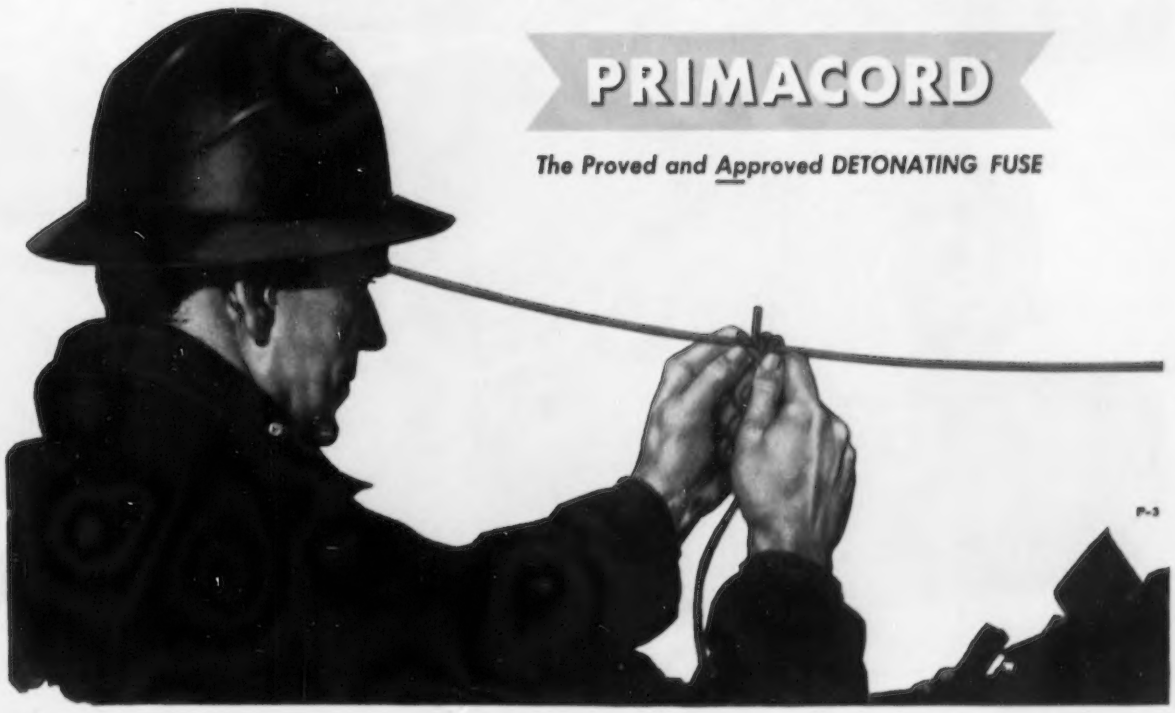


LOOK TO THE ALLIS-CHALMERS LINE . . . TO

Match the needs of your tractor

If you're looking for big capacity, mobility and wide-range versatility — at low cost — the tractor shovel you need is in the Allis-Chalmers line.

First — advanced-design features make Allis-Chalmers tractor shovels the most productive and widely accepted in earth-moving and material handling fields. Second — each unit offers a shovel that's a built-in part of the tractor — not just an attachment. Third — you have a choice of four sizes to match the needs of your jobs most efficiently.

You can increase Allis-Chalmers tractor shovel usefulness even more by replacing the standard bucket with a variety of quick-change attachments, such as a light materials bucket, rock bucket or rock fork . . . or by adding a rear-mounted ripper.

On every job, your Allis-Chalmers tractor shovel provides all these important advantages for you and your operator:

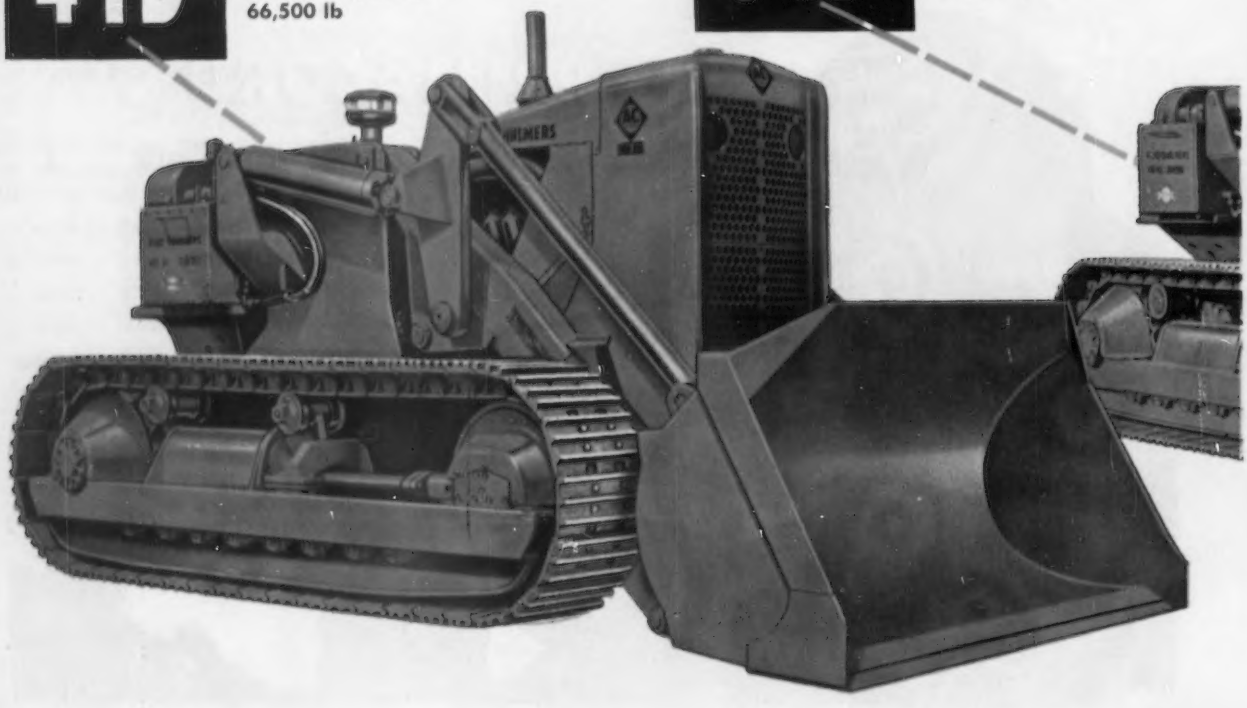
- Superior balance and low center of gravity
- Sure-footed stability with extra long track
- Greater strength with heavy, welded-steel shovel, side frames and low stabilizer
- Bucket design that makes loading and dumping fast, clean and easy
- Simplified hydraulics with 3-way, full-flow filtering
- Powerful, long-life Allis-Chalmers diesel engine
- All-steel main frame and one-piece final drive and steering clutch housing
- Timesaving service simplicity
- Heavy-duty roller bearing truck wheels
- 1,000-hour lube intervals on truck wheels, idlers and support rollers
- Better visibility, comfortable seats, and easy operating, accessible controls

4 YD

HD-21G
torque converter drive
13-ft, 4-in. dump height
204 net engine hp
66,500 lb

3 YD

HD-16G
torque converter drive
12-ft, 3-in. dump height
150 net engine hp
47,800 lb



shovel jobs

1½ YD

HD-6G
10-ft dump height
57 net engine hp
19,600 lb

2¼ YD

HD-11G
11-ft, 7-in. dump height
105 net engine hp
32,000 lb

Ask your Allis-Chalmers Construction Machinery dealer for the complete story and for a look at one of these great tractor shovels at work. And remember, your dealer is headquarters for factory-trained servicemen, factory-approved facilities and complete stocks of True Original Parts.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION
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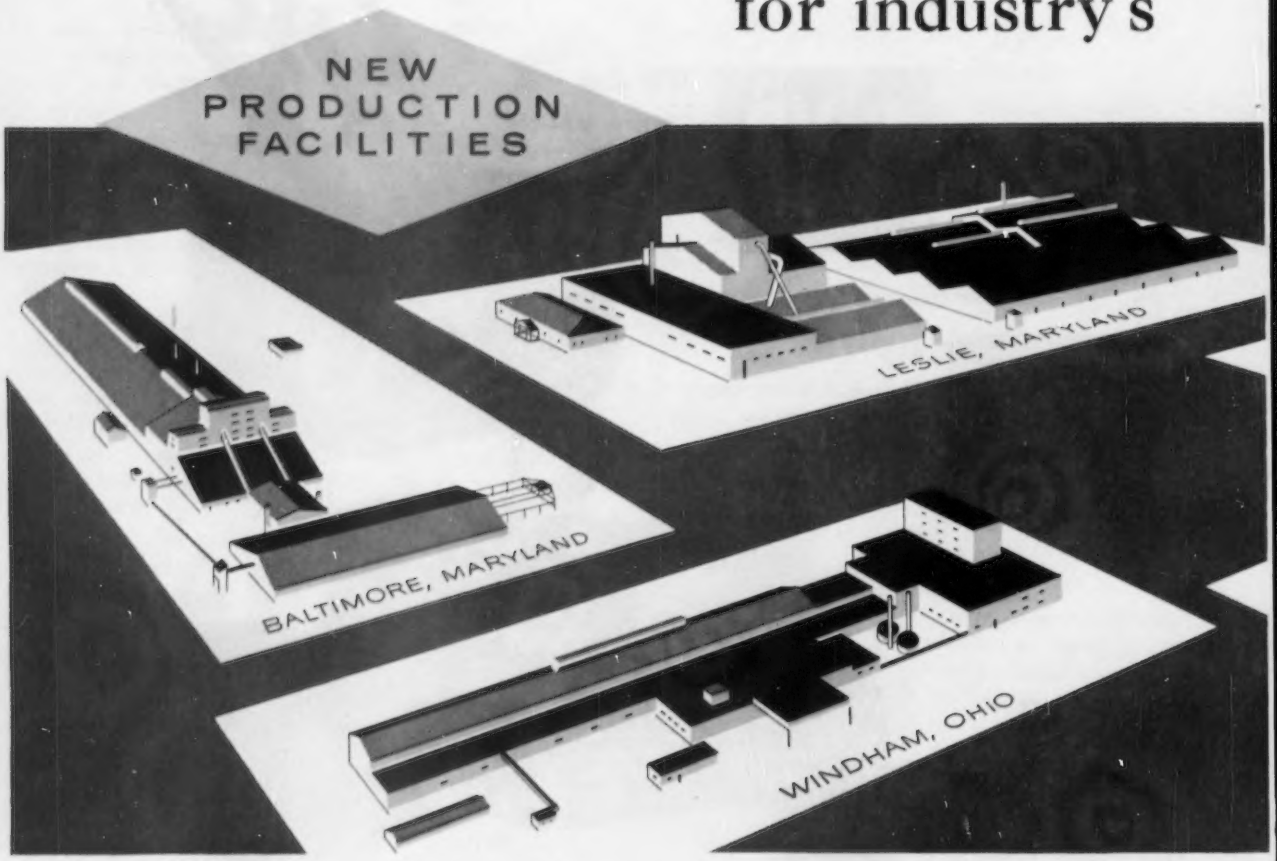
Harbison-Walker BUILDS for industry's

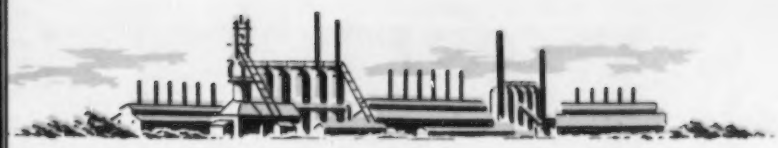


RAPID GROWTH and evolutionary changes in substantially all industrial processes necessitate similar progress in the production of refractories. In order to meet industry's increasing demands and in anticipation of even greater and more exacting future requirements, Harbison-Walker has conducted a continuous program of expansion and modernization. Consistent with this policy, a number of new plants have been built, some of which are here illustrated. Other new plants are under construction at Ludington, Michigan and Hammond, Indiana, the former for the production of dead-burned magnesia of unusually high purity, and the latter for the manufacture of basic brick and other basic refractories. Both will be provided with docks for water shipment. These two new additions provide Harbison-Walker with a total of 36 plants in the United States, Canada, Peru and Mexico. The Company operates scores of mines and quarries located in these areas.

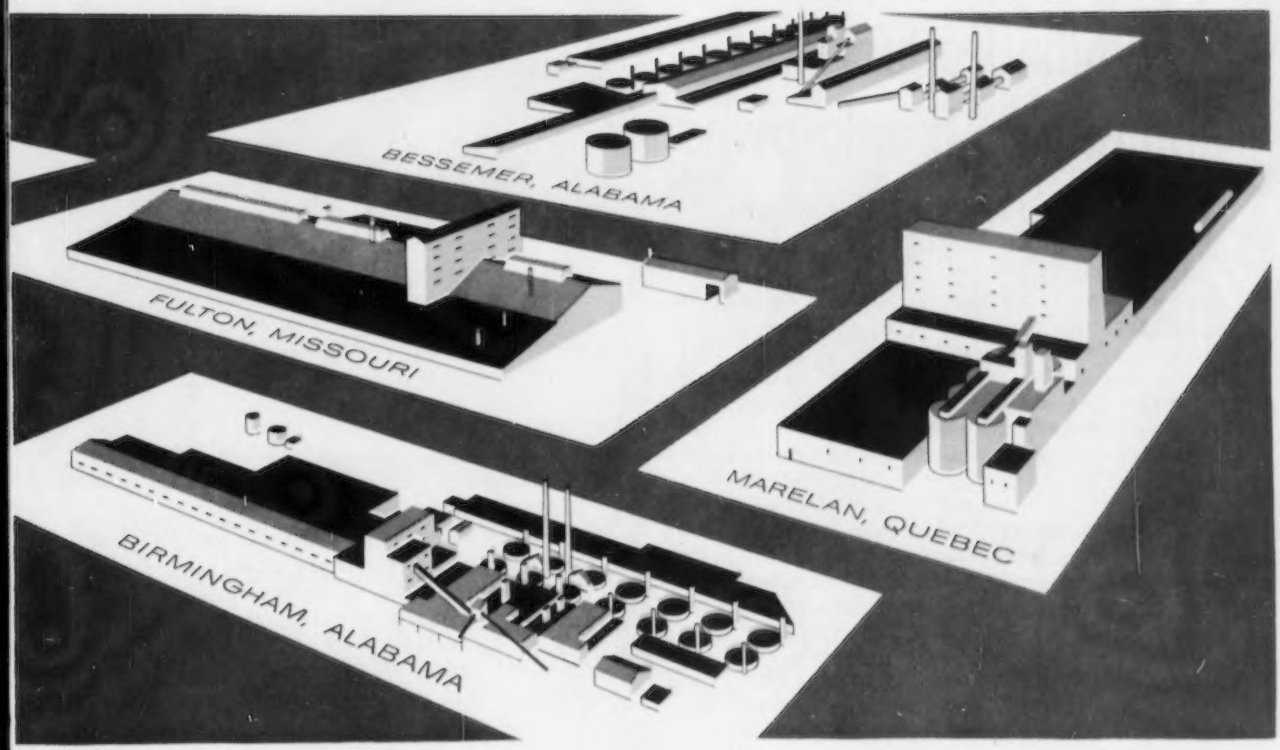
In addition, the production capacities of other plants have been materially increased with the benefit of the most modern facilities. These widely distributed plants are located at Warm Springs, California; Athens, Texas; East Chicago, Indiana; Olive Hill, Kentucky; Portsmouth, Ohio; and Clearfield, Pennsylvania. Further expansion will follow as required.

Coupled with this large expansion is an accelerated research program. A new greatly enlarged central research laboratory will be built in Pittsburgh and the present laboratory then will be converted entirely to Quality Control. Among the main research objectives is the development of new types and classes of refractories needed for new processes and for withstanding more severe service conditions. Another important research accomplishment is the continual enhancement of properties of conventional refractories. Laboratory research is closely co-ordinated with extensive studies of the performance of various refractories in the many kinds of metallurgical and other industrial furnaces.

Harbison-Walker has consistently kept pace with



future refractories needs



industry by the development and adoption of new and improved manufacturing methods. The most modern and precise production processes are used. The present Quality Control Program exceeds anything previously employed in the refractories industry.

These Harbison-Walker progressive accomplishments contribute greatly to better refractory practice for industry. To the producers of iron and steel, aluminum, copper and other non-ferrous metals, cement, glass, chemicals and steam power, better refractories mean longer furnace life, less maintenance and reduced operating costs.

HARBISON-WALKER SERVES ALL INDUSTRIES WITH ALL TYPES AND CLASSES OF REFRACTORIES

ALUMINA-SILICA BRICK—Super-duty, high duty and all other classes of fireclay brick.

HIGH-ALUMINA BRICK—All classes 50% to 99% Al_2O_3 inclusive.

SILICA BRICK—Super-duty and conventional.

BASIC BRICK—Metalkase, periclase, magnesite, chrome, forsterite, chrome-magnesite and magnesite-chrome.

INSULATING REFRACTORIES • PLASTIC AND CASTABLE REFRACTORIES • HIGH TEMPERATURE BONDING MORTARS • REFRACTORY RAMMING MIXTURES • GRAIN AND LUMP SIZE REFRACTORY MATERIALS

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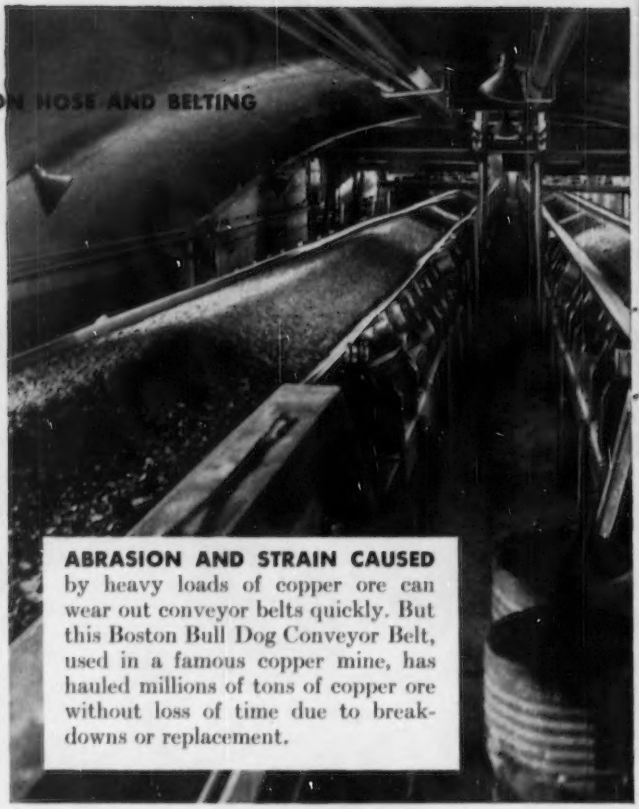
READ WHY SO MANY MINING MEN SPECIFY BOSTON HOSE AND BELTING

How to boost your production and reduce breakdowns at the same time

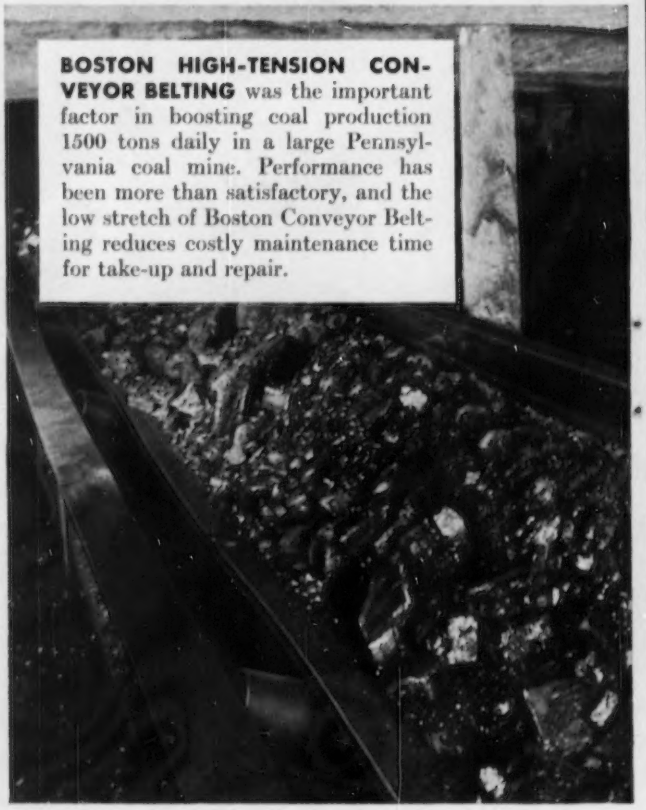
BREAKDOWNS ON ANY MINING JOB WASTE VALUABLE TIME, skyrocket production costs. That's why so many mine operators, engineers and foremen specify Boston hose and belting. They know Boston products help boost production by eliminating costly breakdowns and adjustments. Even on the very tough jobs, Boston hose and belting turn in performance you can rely on!

WHY SO RELIABLE? There's good reason. Boston specializes in industrial rubber products. *It's not just a sideline.* Boston Woven Hose & Rubber Company has one aim: to continue developing industrial rubber products that will outperform all others on the job.

SPECIALISTS IN GOOD SERVICE, TOO. Immediate delivery is no problem for your Boston Distributor. With his thorough knowledge of mining operations and industrial rubber products, he anticipates your needs, prepares to meet them. Better call your local Boston Man today!



ABRASION AND STRAIN CAUSED by heavy loads of copper ore can wear out conveyor belts quickly. But this Boston Bull Dog Conveyor Belt, used in a famous copper mine, has hauled millions of tons of copper ore without loss of time due to breakdowns or replacement.



BOSTON HIGH-TENSION CONVEYOR BELTING was the important factor in boosting coal production 1500 tons daily in a large Pennsylvania coal mine. Performance has been more than satisfactory, and the low stretch of Boston Conveyor Belting reduces costly maintenance time for take-up and repair.

INDUSTRIAL HOSE • FIRE HOSE • BELTING • V-BELTS • PACKING

BOSTON CHECKLIST FOR YOUR HOSE AND BELTING REQUIREMENTS

BOSTON HIGH-TENSION BELTS: Cut your operating costs on long center and high lift conveyors with Boston High-Tension Belts. They need fewer, lighter plies to carry heavy loads. Boston's Rotocure process makes this possible by eliminating mechanical distortions and uneven stretch.

BOSTON CONVEYOR BELTS: Specific job engineering for length of haul and type of load means Boston belts give you outstanding performance on every job. One Boston Silver King Belt still serves a major coal company in Virginia after 20 years (the original drive wore out after 15 years).

BOSTON CUSTOM CONVEYOR BELTS: On special applications, Boston's know-how teams up with Boston's Rotocure process for job-right performance. One specially engineered Boston belt, used by a large iron mine on the Mesabi Range, lasted five times longer than competitive belts!

BOSTON TRANSMISSION AND V-BELTS: You get increased operating efficiency wherever you use Boston Transmission and V-Belts because they are specially designed to eliminate slippage, require fewer adjustments. That means fewer breakdowns, less wear and tear on motors.

BOSTON HOSE: Your Boston Man has a complete line of air hose, water hose, face hose and rock-dusting hose designed and engineered by Boston to give you superior performance, even on the tough jobs. His experience will help you pick the right hose for every application.

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BOSTON BOSTON WOVEN HOSE & RUBBER COMPANY
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Specialists IN INDUSTRIAL RUBBER PRODUCTS

NEW PURCHASING GUIDE *FREE!* Now, right at your fingertips, all the facts you need to know about the rubber products you use in mining. Saves you time and money, helps you get the right equipment in a hurry. Mail coupon today!

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Rush me a free copy of your mining rubber products purchasing guide.

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In California...and the World Over
Bucyrus-Eries Live Up to Reputation for High Output

Bucyrus-Erie 6-yd. 150-B shovel working at Eagle Mountain mine. Ore bearing formations here are high in iron content and considerably heavier than most rock.

Miners the world over have learned to expect outstanding performance from Bucyrus-Erie Ward Leonard electric shovels — and they get it, no matter how tough the assignment.

The machine above, for instance, is on a California project where it handles massive, heavy iron ore and waste rock — an extremely hard, fine rock which is quite abrasive. It's a true test of an excavator's strength and durability but here, as on other tough jobs the world over, the Bucyrus-Erie shovel moves big yardages economically — day after day, month after month.

It's the *extra margin of quality,* both in design and manufacture, that qualifies Bucyrus-Erie Ward Leonard electric shovels for world-wide acceptance — and lets them live up to it. We would like the opportunity of explaining that extra margin of quality — and what it can mean in performance on your job. 96156

GLOBAL APPROVAL
MOROCCO · PHILIPPINES · RHODESIA · UNITED STATES · VENEZUELA · ALGERIA · CANADA · CONGO · ENGLAND · FINLAND · FRANCE · INDO-CHINA
110-B 4½-cu. yd.
150-B . . 6-cu. yd.
190-B . . 8-cu. yd.
BUCYRUS ERIE

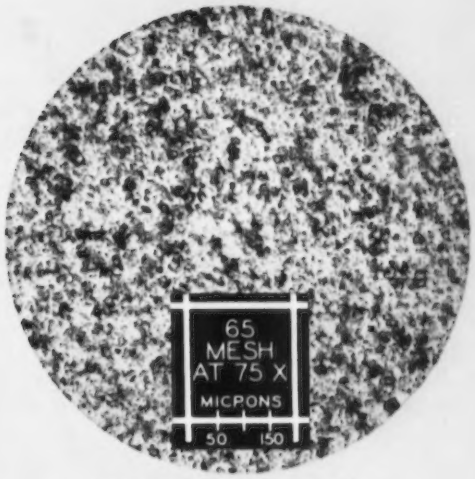
BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

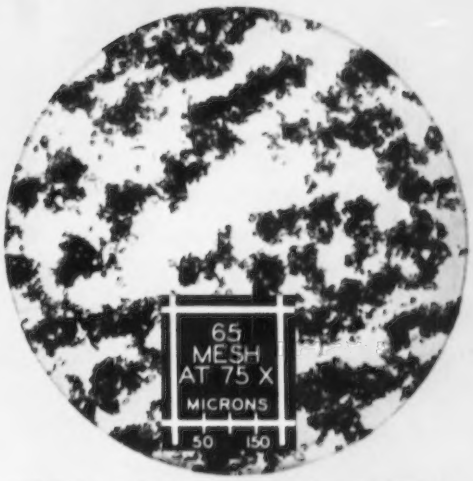
AEROFLOC® Reagents

Efficient and Easy to Use

for Improved Settling and Filtration by Powerful Flocculation at any pH.



UNFLOCCULATED SLIMES



AFTER ADDING AEROFLOC REAGENTS

Perhaps you've already heard how effectively AEROFLOC Reagents speed up and improve complete settling of concentrates, tailings or leach residues—thus conserving values in thickener overflow and reducing solids in plant effluent.

Perhaps you've already seen data on how AEROFLOC Reagents increase filtration rates, make filter cakes firmer and more porous, reduce blinding of filter cloth, aid washing.

But did you know that AEROFLOC Reagents

- ✓ Are effective at very low concentrations—0.1 to 5 ppm, or 0.01 to 0.1 lb. per ton dry solids.
- ✓ Are water soluble with simple agitation, requiring a minimum of labor for mixing and feeding.
- ✓ Require no elaborate feeding equipment.
- ✓ Can be added wherever plant tests show best results. Stagewise addition usually not necessary.

Three AEROFLOC Reagents—#548, 552 and 3000—are now available. You should test all three to determine which is most efficient on your mill. We'll be glad to provide samples for bench tests and the services of a Cyanamid Field Engineer to work with you on plant tests. The handy coupon is for your convenience.

AMERICAN CYANAMID COMPANY
MINERAL DRESSING DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

CYANAMID

Please send me samples. ☐

I would like to settle ☐ filter ☐ _____

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

SULPHUR

helps to create HEADLINE products

PAVING

FLOTATION OILS

INKS

VARNISHES

TALL-OIL

CLOTH

CUTTING OILS

RUST-PROOF COMPOUND

PAINT

SOAP

New uses are popping up everyday for this refugee from the skimmings of kraft mill black liquor. Tall Oil is fast becoming the antidote to a lot of supply shortage headaches and cost problems.

That Tall Oil is extracted from black liquor skimmings with the aid of sulphuric acid is perhaps not as interesting as the fact the process is carried on at subzero (centigrade) temperatures with highly concentrated acid. Most applications of sulphuric are at room temperature or higher.

Here is a relatively new product, certainly a 'headline' product and it requires a derivative of Sulphur in the reactions that make it!

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Sulphur Producing Units

- Newgulf, Texas
- Moss Bluff, Texas
- Spindletop, Texas
- Worland, Wyoming

Longyear

There's a new "44" winning the West!

Heavy duty "44"
4000 ft of AW Rod

Tight drill schedules maintained in rugged country with

LONGYEAR TRUCK MOUNTED "44" CORE DRILL

LOG BOOK REPORT . . . "Finished pulling rods at 4:00 P.M.—Commenced drilling at New Location 4:25 P.M."
The Longyear "44" combines fast moving advantages with design for speedy set-up and all around convenience for the driller.

This "Drill Camp on Wheels" incorporates the latest in modern design of Hydraulic Swivel Heads for maximum drilling efficiency such as a built-in slide to move drill out of the way when hoisting rods . . . tubular steel fabricated mast hydraulically raised . . . water tank of 500 gallons capacity . . . Longyear Model 535 Pumping Unit with capacity of 35 GPM at 500 P.S.I. . . . Oil Hydraulic Pump which operates the Hydraulic Swivel Head and raising and lowering of the Mast . . . racks for transporting drill rods and casing.

The Longyear "44" was designed to meet the driller's demands determined by actual field experience. Maximum core recovery at minimum over-all cost can only be achieved by use of modern core drill equipment, designed exclusively for core drilling. The LONGYEAR "44" is such a drill.

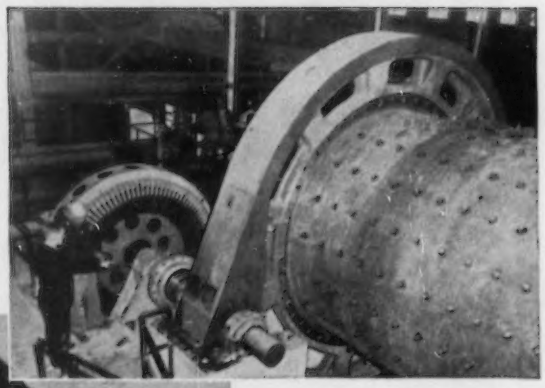
Write for free illustrated bulletin.

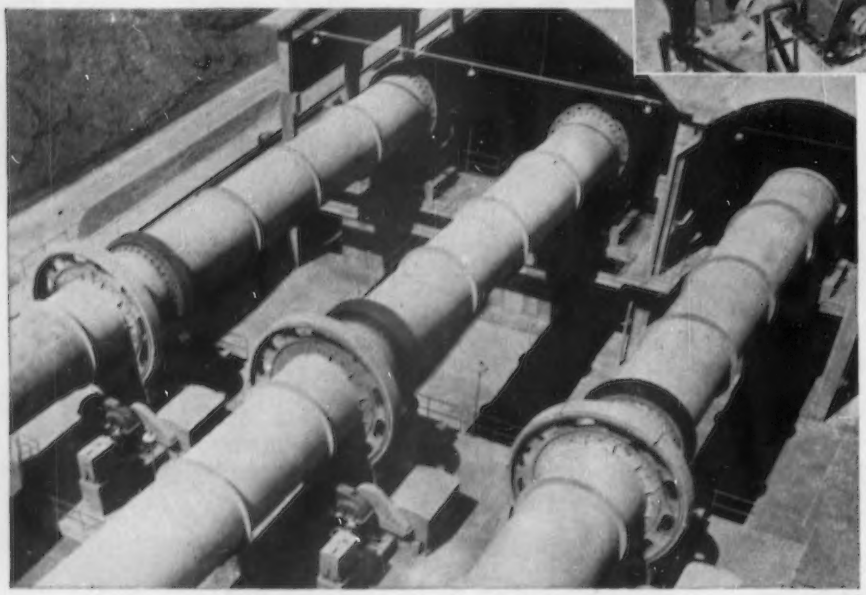
WRITE FOR BULLETIN No. 90R!

E. J. Longyear Co. MINNEAPOLIS, MINN. · CABLE LONGCO
CANADIAN LONGYEAR LTD., NORTH BAY, ONTARIO · LONGYEAR ET CIE., PARIS, FRANCE

FALK

Modern Gears for Modern Needs





ABOVE: A 10 ½′ x 12′ ball mill with Falk helical gear and Steelflex coupling.

LEFT: 10′ x 340′ rotary kilns driven by Falk single helical gears, reducers and Steelflex couplings.

Are your costly gears wearing out? Falk Helical Gears wear in!

Operators and engineers know that the action of ever-present abrasive particles on gear teeth is the arch-enemy of gear performance and gear life. They know that, when spur gears are used, abrasion tends to damage the tooth profile (thus lessening the smoothness of power transmission)—and ultimately destroy the gear teeth.

The sure way to reduce costly gear damage to an absolute minimum is to use Falk Precision-Hobbed Helical Gears. On these, the gear teeth are on a helix; this means that all phases of profile contact ("rolling" and "sliding") exist at the same instant. Pressure and abrasive wear on "sliding" tooth surfaces are reduced, smooth transmission of power is assured, and *the life of gears and connected machinery is extended.* With several teeth sharing the load at all times, the teeth actually wear themselves *in,* instead of *out!*

You will find long-range economy in specifying "Gears by Falk" whenever you expand or revamp your facilities. Falk is *the manufacturer* best prepared to recommend and produce the exact helical gear—single or herringbone type—most suited to your application. Falk's leadership in precision gearing is recognized the world over.

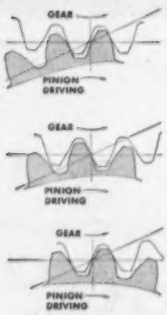
Consult the Falk representative nearest you—
also, **write for Report 6170,** "Advantages of Helical Gearing."

THE FALK CORPORATION, 3001 WEST CANAL ST., MILWAUKEE 8, WISCONSIN

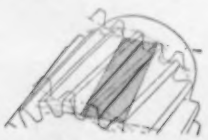
GEAR FACTS FOR ENGINEERS

As each spur gear tooth picks up the full load, the relative motion between the driving and driven tooth is a sliding action. As rotation continues, this motion becomes rolling at the pitch point, changing to sliding action again as the tooth advances toward disengagement.

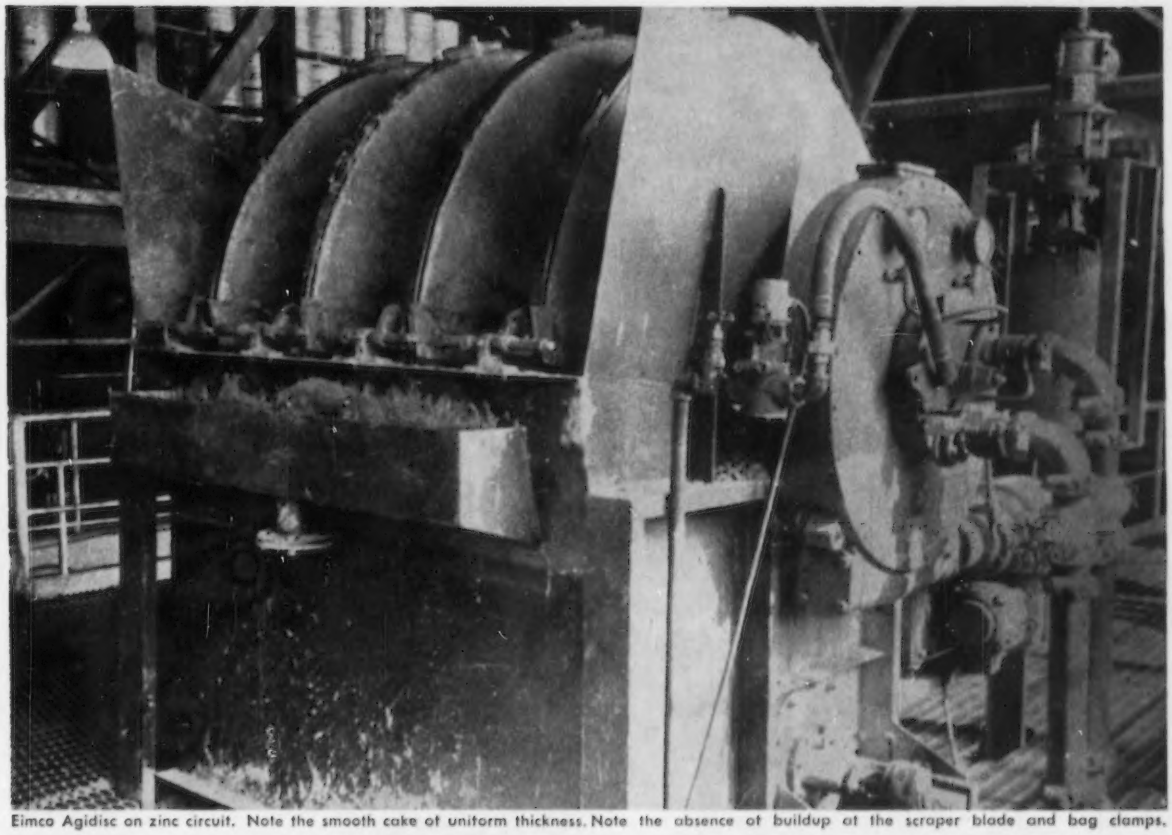
PHASES OF INVOLUTE GEAR TOOTH ACTION



Helical gears have several teeth sharing the load. Teeth are simultaneously in all phases of contact across profiles, with contact starting at the tip of the teeth and extending obliquely to the base, thus reducing unit pressures. Also, portions which are rolling will limit the pressure exerted on portions which are going through sliding.

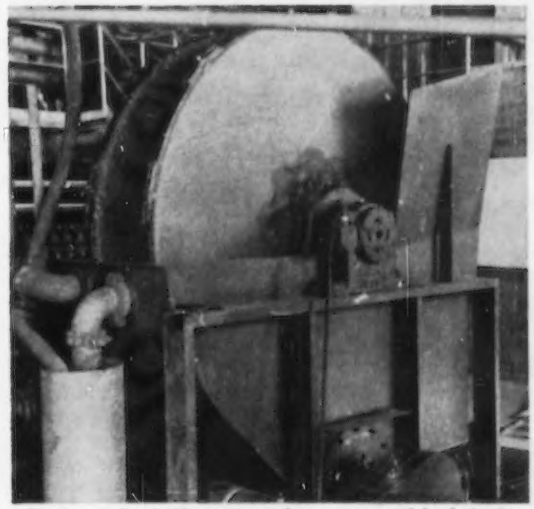


When abrasive materials contaminate the lubricant and get into the gear mesh, the more one can limit pressures in sliding areas, the less grinding action (hence wearing away) there will be.



Eimco Agidisc on zinc circuit. Note the smooth cake of uniform thickness. Note the absence of buildup at the scraper blade and bag clamps.

LOW MOISTURE AT HIGH ALTITUDES WITH EIMCO AGIDISC FILTERS



Eimco two disc Agidisc type used on copper and lead circuits.

Metallurgical concentrates being dewatered in a mill at approximately 9,000 ft. elevation are handled on three Eimco Agidisc filters, one each for lead, copper and zinc circuits.

The ore is ground to 50%—200 mesh and dewatered on the Agidiscs equipped with snap blow device to provide maximum cloth life and tonnage.

Most important is the moisture content of these dewatered concentrates discharged from the filters at this altitude. The monthly average runs; lead 8.0%, copper 9.5% and zinc 10.3%.

Operation of these filters is best expressed in the words of the Superintendent of the mill who says, "their (Eimco Agidiscs) operation is so trouble-free that we have paid no attention to them and feel that when we get time from the other parts of the circuit we will undoubtedly be able to improve the present moistures."

Your problem in dewatering a metallurgical concentrate can be solved by Eimco's filtration engineers. Call on Eimco for the experience and facilities to solve your problem.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Baltimore, Md. Pittsburgh, Pa. Seattle, Wash. Pasadena, Calif. Houston, Texas Vancouver, B. C. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

B-204

Using Bethlehem Hollow at Moretti-Harrah Marble Co. quarry, Sylacauga, Ala. Drill steel supplier: Cowin Equipment Co., Inc., Birmingham, Ala.

Drilling deeper and deeper into Alabama marble

Most any day you can see plenty of broaching and drilling activity at the quarries of Moretti-Harrah Marble Company, Sylacauga, Ala., where they are quarrying large quantities of white marble, using Bethlehem Hollow Drill Steel.

Bethlehem Hollow Drill Steel, used exclusively by Moretti-Harrah, performs in drifters and jackhammers in 1¼-in. round and 1-in. hexagon, fitted with detachable bits. Where blasting is required, holes are drilled 14 ft deep. Reconditioning is done in their own shop, at the quarry site.

You can depend on good service from Bethlehem Hollow, no matter what the type of rock. Bethlehem Hollow is rolled from a special grade of fatigue-resistant steel, and has a uniform hole, centrally located in the bar. It has a wide quenching range, and is easy to heat-treat for the proper balance of toughness and wear-resistance, resulting in long-wearing threads and strong shanks.

MADE IN TWO TYPES

Bethlehem Hollow comes in carbon and ultra-alloy, in rounds, hexagons and quarter-octagons, in lengths up to 25 ft. Longer lengths can be supplied to meet special conditions. Give Bethlehem Hollow a try. Order it from your local converter.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL CARBON AND ULTRA-ALLOY

BETHLEHEM STEEL

Eimco 630 Tractor-Excavator is air powered for tunnel operation.

EIMCO 630 EXCAVATORS SPEED DEVELOPMENT

High speed development can be maintained underground with only the normal shift crew. The Eimco 630 helps the miner or contractor realize this goal because it operates faster and requires no track.

The Eimco 630 Excavator is mounted on the Eimco 630 air or electric (A.C.) powered tractor and the combination unit provides the operator with a really mobile and versatile loading machine.

With its independently controlled tracks the Eimco 630 Excavator can dig in at the toe of the muck pile, bulldoze out into stations cut along the side, walk over, around and through unworkable areas in the mine eliminating the necessity for laying rails.

It is also in use for shaft sinking in round and rectangular shafts. It is being used on slopes and for mucking out sub-level ore pockets.

In all of the applications where the 630 has been employed the costs of handling the material have been less than with previously used equipment.

The Eimco 630 is rugged, requires a minimum of maintenance attention and has the same dependability that has been characteristic in Eimco made equipment for more than half a century.

Write for complete information.

THE EIMCO CORPORATION

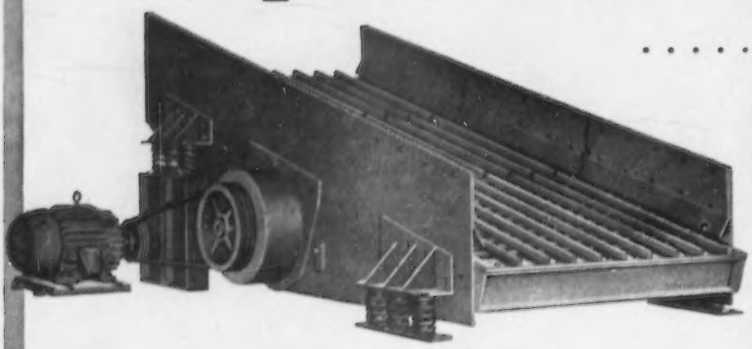
Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Baltimore, Md. Pittsburgh, Pa. Seattle, Wash. Pasadena, Calif. Houston, Texas Vancouver, B. C. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

B-306

Before you buy a heavy-duty scalper...

ask yourself these 4 questions



1 **Has it the strength to take 40-in. boulders dropped from a feeder?**

2 **Can it deliver high output?**

3 **Does it provide efficient separation?**

4 **Is it designed for trouble free operation?**

Link-Belt heavy-duty scalping screen effectively keeps fines out of primary crushing circuit.

The answer to all 4 is YES-- when you choose this proved LINK-BELT Vibrating Screen

Here's how these Link-Belt Vibrating Screens live up to the four major demands of heavy-duty scalping.

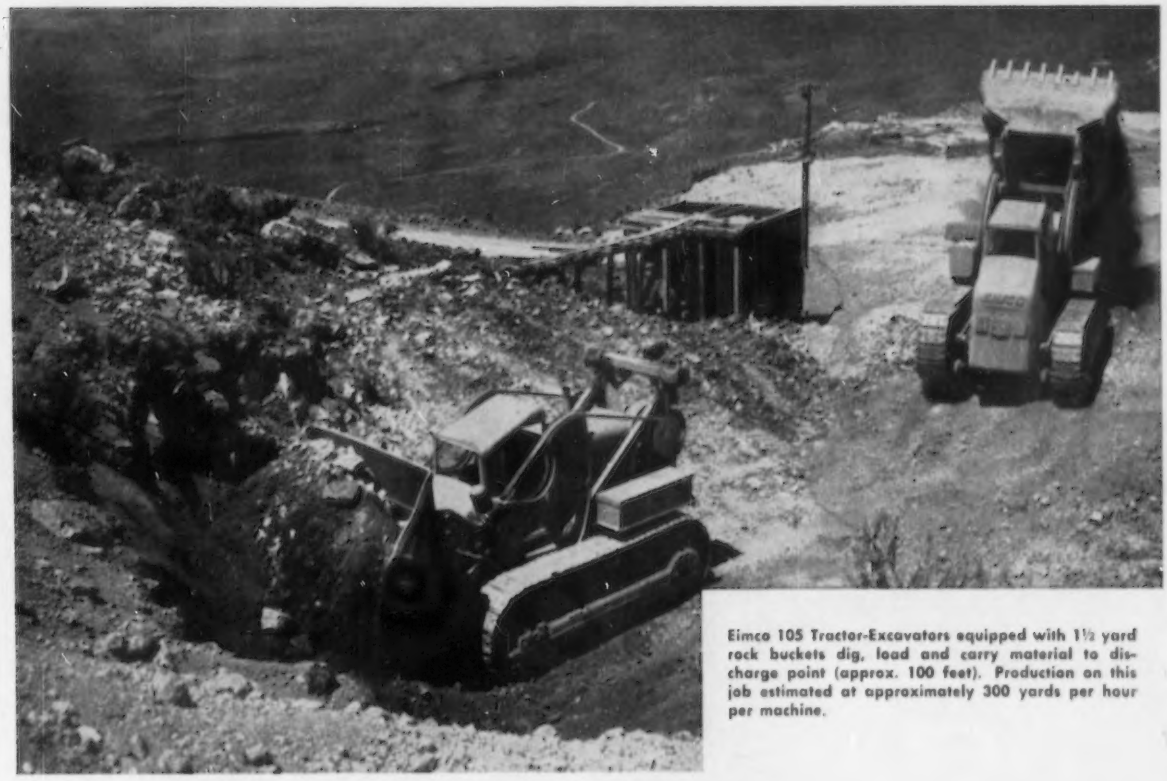
1. **Great strength** — Massive frame has heavy-section ship channels and H-beam members, is stress-relieved to assure maximum strength and withstand impact loads without distortion. Welded deck firmly riveted to thick side plates.
2. **High capacity** — Efficient, blind-free operation permits screening of sticky ores at extremely high capacities. Deck can be either perforated plate or grizzly.
3. **Effective separation** — All vibration is isolated from foundation by large, square-end helical springs and concentrated in live deck for thorough action of deepest bed.
4. **Easy Maintenance** — Simplified two-bearing design of vibrator mechanism and unique hydraulic bearing removal device plus ready access to screen cloth speed maintenance.

For more details and data on this durable, powerful screen, see your Link-Belt representative or write for Folder 2461.

LINK-BELT 13,058

VIBRATING SCREENS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



Eimco 105 Tractor-Excavators equipped with 1½ yard rock buckets dig, load and carry material to discharge point (approx. 100 feet). Production on this job estimated at approximately 300 yards per hour per machine.

SPEED, VERSATILITY AND DEPENDABILITY WITH EIMCO 105 TRACTOR-EXCAVATORS

Eimco 105 Tractor - Excavators, shown above, dig and load more rock at less cost per yard than any other earthmoving machine.

These Eimco Excavators are multi-purpose machines. They are easily and quickly moved from one spot to another where work is needed. They are used as prime movers, on production excavation and loading jobs, for bulldozing and other work around the plant.

In production work, the Eimco 105 Tractor-Excavator will load in rock at the rate of 5-6 yards per minute and in easier materials such as sand and gravel, the 105 will load as much as 8-9 yards per minute.

Eimco 105's do a better job than the conventional tractor mounted machine because of Eimco's exclusive operating features. Independent track operation increases the effectiveness of the machine in speed of maneuverability, saves travel time and wear and tear on track assemblies, chains and all crawler parts.

The Eimco power shift saves wear and tear on operators, keeps them fresh and alert all day long. Operator position up front makes it possible to see what is being done.

All cast-alloy steel parts are standard equipment on Eimcos at no extra cost. Torque converters, also standard, provide better engine operating flexibility and protect the engine from shock.

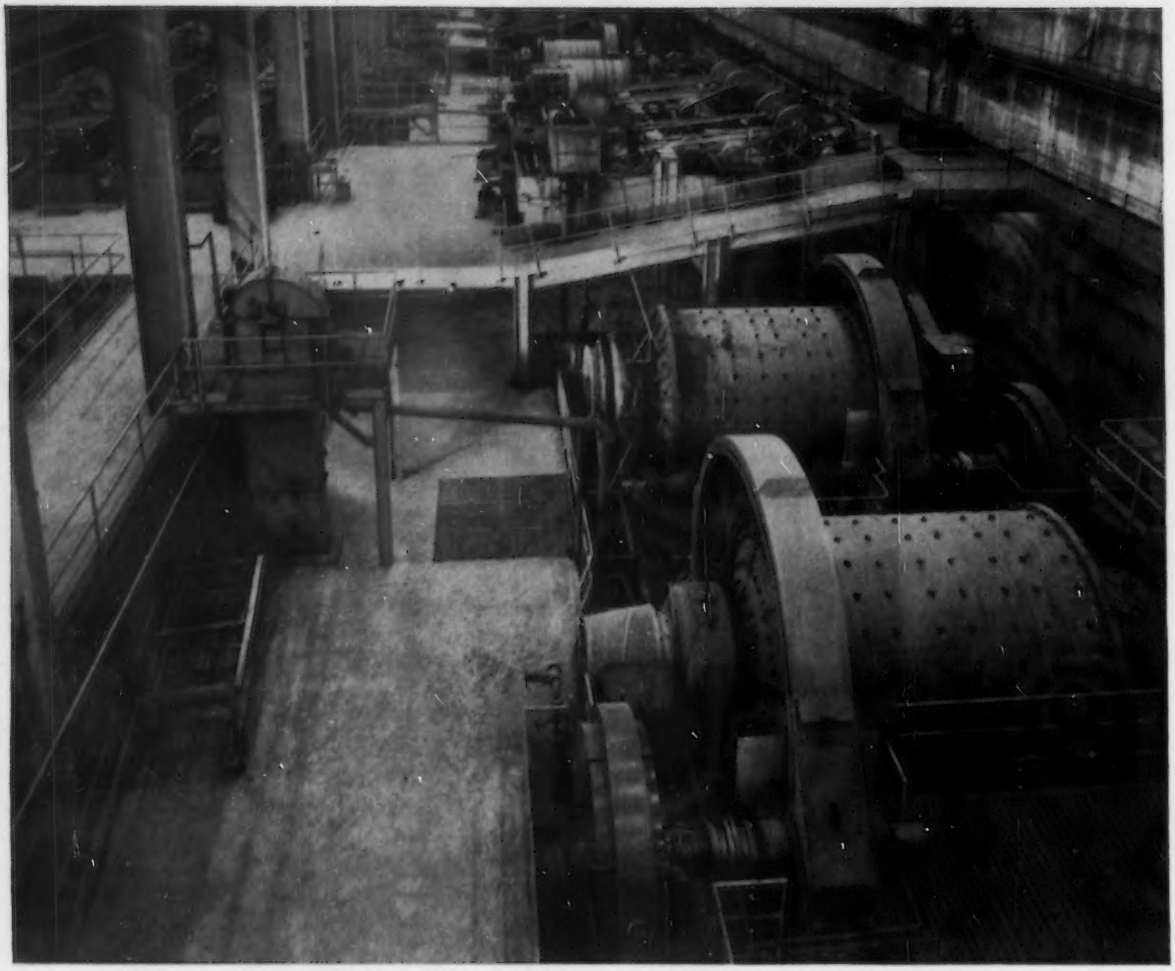
Eimco 105's are different in construction, design and operation. They are the only really modern tractors in production today. An Eimco engineer will be glad to tell you about the 105 and answer your questions. When you need a Tractor or Tractor-Excavator be sure to see an Eimco 105 at work, and talk to people using them. You are invited to compare the Eimco 105 Tractor, piece for piece with the tractor you are using or any other tractor.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Baltimore, Md. Pittsburgh, Pa. Seattle, Wash. Pasadena, Calif. Houston, Texas Vancouver, B. C. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

B-207



Ni-Hard liners save labor, cut maintenance and grinding costs by providing the utmost in tonnage life. Results obtained in our own grinding aisle show economies you can count on for your own mills.

Ni-Hard shell liners wear only .018 lb. per ton grinding more than 3 million tons of nickel ore

This high tonnage life demonstrates the outstanding performance of Ni-Hard* nickel-chromium white iron shell liners in the concentrator shown above.

Only recently, two sets of lifter bar liners were removed from rod mill service in this plant, Inco's Creighton concentrator, which began operating in 1951.

Used in large mill

The Ni-Hard shell liners served in 10′8″x13′ mills grinding highly abrasive nickel ores with 3″ and 3½″ rods. Mills ran at 60% of critical speed. At the discharge, solids in the slurry ran 70%. Total life in the #1 mill was 3,430,000 tons of ore; in #4 mill, 3,266,000 tons. The liners for each mill originally weighed 60,912 lbs.

This example of Ni-Hard shell liner service is a severe one . . . nickel ores are among the toughest. But the record of Ni-Hard liners in such service shows what this material can do for your grinding operations.

Where your abrasion is severe . . . use Ni-Hard liners.

*Registered Trademark

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

How to beat a fleet of limited-duty rigs ...WITH ONE International® Drott 4-IN-1

Beat a power shovel wherever exclusive Drott *triple-power, pry-action break-out* is decisive—and where quick International crawler mobility can outspeed and "out-reach" a boom. Break-out force of the three Four-In-One models as Skid-Shovels ranges from 12,800 to 55,000 lbs!

Gain a 30-inch (or greater) dumping height advantage over ordinary roll-forward bucket dumping—by using the bottom-dump feature of the Four-In-One as a clamshell. And loading with the clamshell action, get a super-fast bucket-fill on stockpiled materials, even in cramped quarters.

Get versatile carry-type scraper action with the Four-In-One in Bullclam position. Using positive clam lip control, spread materials, strip, and grade with amazing accuracy. And as a Bullclam, the Four-In-One *heap-loads* itself with speedy, earth-boiling action!

Get big dozing capacity with finger-tip ease with your Four-In-One in bulldozer position. Regulate dozing depth by hydraulic "radius control" of blade pitch. Note the frost-breaking, earth-moving action. Shown here is new 2¼-yard Four-In-One for the International TD-14.

Prove Four-In-One versatility unlimited with the 1-yard TD-6, the 1½-yard TD-9, or the new 2¼-yard TD-14 model. Test *exclusive* pry-over-shoe break-out action, and *exclusive* shock-swallowing Hydro-Spring. Ask your International Drott distributor for a Four-In-One demonstration.

International Harvester Company, Chicago 1, Illinois

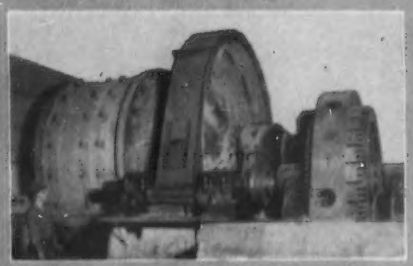
INTERNATIONAL® DROTT

Marcy

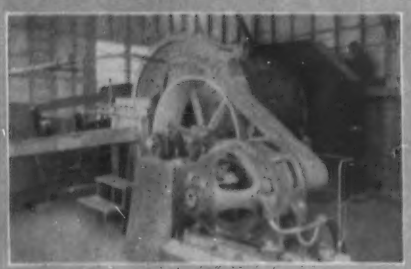
EXPERIENCE...

your best assurance of economical operation

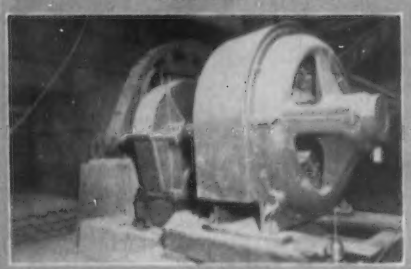
Nothing can take the place of EXPERIENCE... and Mine and Smelter has specialized in the design and manufacture of grinding mills for more than forty years. This experience in design, materials and construction is your assurance of getting long, economical service out of Marcy Mills.



Direct connected drive with flexible coupling



V-belt drive.



Speed reducer drive.

for example...

DRIVES AND GEARS

- the types of drive and gears used are custom-engineered for each Marcy Mill to assure dependable, continuous operation and long, trouble-free operation... one of the many Marcy Mill features which result in low-cost-per-ton production.

- **drives may be**

  direct connected with flexible coupling using cut tooth single helical or herringbone steel gears.

  V-belt or speed reducer drive with meehanite cut tooth spur gears.

  variable speed drives for special applications.

- single helical and herringbone gears are made to American Gear Manufacturers Association recommendations as to tooth shape, size, material specifications, etc., assuring long life and efficiency. This, combined with precision gear cutting, provides an extra high service factor.

*BOTH MARCY AND MASSCO ARE REGISTERED TRADEMARKS.

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The Mine & Smelter Supply Co.
Denver 17, Colorado

OFFICES IN SALT LAKE CITY, EL PASO, 1775 BROADWAY, N. Y. C.

GENERAL REFRACTORIES

Your home is made with BRICK . . . *no matter what you build it of!*

Your home—from roof to cellar—and everything in it: the windows to look from . . . the lights to read by . . . the rugs to walk on . . . the chairs to sit in—even the work-saving appliances in your kitchen and the clothes in your closet. Everything that's made . . . everything that moves owes its very existence to refractories.

You see, refractory brick carries the load within industry. But, beyond industry, everyone comes in direct contact with refractories in daily living. The making of refractory products is the most basically necessary industry—with the exception of agriculture—there is.

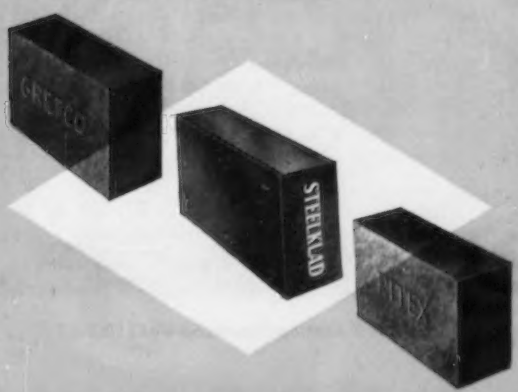
To provide the right refractory industry needs—castables, plastics, ramming mixes, firebrick, mortars, insulating brick and insulation—General Refractories operates the world's largest refractories research laboratory . . . constantly seeking perfection . . . drawing resources from all over the globe.

A Complete Refractories Service

GENERAL REFRACTORIES COMPANY
Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE COPPER INDUSTRY

Three types of basic brick—RITEX, GREFCO, STEELKLAD for the three basic processes—smelting, converting and refining. Each type of brick available in the ranges of composition—Magnesite, Magnesite-Chrome, Chrome-Magnesite and Chrome—required to adapt to variations in metallurgical processing.



RITEX—chemically bonded for low cost, superior workmanship, resistance to spalling, ready availability.

GREFCO—conventional type bonded by tunnel kiln high temperature firing, for maximum strength and hardness.

STEELKLAD—steel encased on two, three or four sides and for special jobs, steel plates incorporated in the brick interior as well—for maximum resistance to spalling in the most severely treated exposed walls.

RITEX, GREFCO and STEELKLAD—each the result of many years of intimate knowledge of the copper industry and careful study of service conditions, each prepared from the best available raw materials and made with the most modern manufacturing facilities—all within easy access to your operation.

Haul underground.
KOEHRING COMPANY, Milwaukee 16, Wis.
Subsidiaries: PARSONS
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K548

. . or on the surface with Dumptors

Trackless mining — Hauling zinc ore from underground mine to railroad siding, 3 Koehring Dumptors ramp-load directly into cars. On this trackless haulage operation, the 6-yard Dumptors are loaded underground by a tractor-shovel. They travel along tunnel to an inclined haul-way, where they have an 1100-foot climb up 11½% grade to the mine entrance. Production for the 3 heavy-duty haulers has averaged 500 tons of ore a day — and the mine foreman reports that maintenance has been "almost nil". It's easy to see why. For one thing, Dumptors have no troublesome body-hoists. *Gravity* dumps the load — and gravity-dump never balks, never wears out.

14 Dumptors in one mine —

On extensive open-pit stripping to uncover lithium deposits, rocky overburden is hauled by a fleet of 14 Koehring Dumptors. They also carry ore from pit to stockpile. Excavating is handled by tractor-type loaders and power shovels. Notice how Dumptor's big square body opening and low rear entry permits fast loading over the end or sides.

Up-hill haul all the way —

Teamed with a Koehring 1½-yard shovel, 3 Dumptors haul up steep grade out of pit, then climb ramp to dump. These off-road 6-yard Dumptors have better than 6 h.p. per ton of loaded weight. They accelerate fast, pull through soft ground, up grades with less shifting, climb 24% grades fully loaded.

Prospecting for pay dirt —

At exploratory mine in the Rocky Mountain region, Dumptor goes underground, shuttles in and out of access tunnel without turning. There's no need to turn, because Dumptor has 3-speed travel in either direction — operates with equal ease coming or going. It's as efficient underground as it is on overhead trestles, or hauling along the surface.

If your work involves hauling rock, gravel, ore and other materials under difficult conditions, let your Koehring distributor show you what this 6-yard heavy-duty Dumptor® can do for you.

New Stoper Drill Design Combines 30% Reduction in Weight with 10% Faster Drilling Speed

Use of modern materials in new Le Roi-Cleveland S-10 Stoper results in easier handling.

With the introduction of the new Le Roi-Cleveland S-10 Stoper, great strides have been made in easing the work-load of miners. At the same time, their productivity, in terms of footage drilled per shift, has been increased.

New stoper uses aluminum feed leg to help decrease weight as much as 30% and provide better balance. This type of feed leg, already so successful on Le Roi-Cleveland Air Legs, contributes greatly to weight reduction: The S-10 with 18-inch steel change weighs only 79 lbs!

10% faster drilling speed results from a combination of design features: The new valve is timed and ports are arranged so that a maximum flow of air is delivered to the piston on both downstroke and upstroke. Hard-hitting, rock-shattering blows result, along with a rotation that's strong enough to turn the steel in the worst kind of drilling.

The variable feed-pressure control also adds greatly to the performance of the S-10. It has a wide enough range to feed the machine properly against all kinds of rock. Maximum drilling speed is attained. At the same time, both bit life and machine life are increased.

Exclusive steel puller permits the use of collared steel. This is of special advantage in tight ground, where stuck steels used to be a problem. The new steel puller, consisting of only 5 parts, also makes stoper operation safer. Since the steel never leaves the machine, the danger of falling drill steel is eliminated. The new S-10 Stoper is also available with tappet-type construction for shankless steel.

Three sizes of feeds are available. The S-10 can be supplied with 18, 24, and 30-inch steel changes for ⅞ and 1-inch hexagon or quarter-octagon steels, with or without collared shanks.

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RD-83

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the BIG SCREEN for the BIG JOBS

- **Extra-Large Mechanism**
- **12-inch I-Beam Deck Support**
- **Takes Punishing Loads**

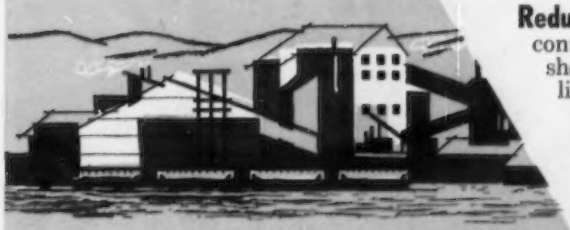
Here is an extra heavy duty screen engineered to team up with primary crushers in handling the toughest job in any mining flow. Design features of this rugged screen include a cartridge-type, oil-lubricated mechanism with giant size bearings and a 12-inch I-beam in channel-constructed top deck support frame. The bearings, largest ever installed in a vibrating screen, are designed for long term service under heavy load conditions. The sturdy channel construction of the screen deck support frame can withstand the impact of single pieces weighing as much as 8000 pounds.

Reduced Maintenance — Simplified two-bearing, cartridge-contained mechanism can be pulled out after removing sheave and four bolts. Large size bearings mean extended life, less frequent replacement.

Vibration Isolation — Standard design includes multi-unit vibration isolators — two per corner, each with an inner and outer spring arrangement. Vibration to building or structure is isolated even when materials adhere to screen.

A-5051

Performance proved on the *Mesabi* range . . . one of the toughest testing grounds in the world.



For complete information, see your A-C representative or write for Bulletin 07B8368. Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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ENGINEERING AND MINING JOURNAL

JULY 1956

Clyde E. Weed, President of The Anaconda Co.

Thomas A. Campbell, Vice President of The Anaconda Co.

Charles M. Brinckerhoff, Vice President of Chile Exploration Co. and Andes Copper Mining Co.

Mining Engineers Do Get Ahead

MANY LETTERS sent to *E&MJ* by mining engineers over the past decade have carried an undertone of discouragement because of the questionable status accorded mining engineers by some companies. Some letters quoted mine operators who said they "could get engineers for a dime a dozen." Others deplored the fact that key mining positions were going to lawyers, industrialists, bankers, doctors, dentists, etc.

Lest it be assumed that this situation is general in the mining industry, we would like to call your attention to the recent election of three engineers to prominent offices of The Anaconda Co., and its subsidiaries. Clyde Weed has been elected president of The Anaconda Co. and three subsidiaries. Thomas Campbell has been elected vice president of the company, and Charles Brinckerhoff has been elected vice president of two subsidiaries, Chile Exploration Co. and Andes Copper Mining Co.

Clyde Weed graduated as mining engineer at Michigan College of Mines, started as a miner, and worked his way from foreman at Inspiration to his present high position. Weed Heights, site of Anaconda's operations near Yerington, Nev., has been named as a tribute to his leadership and engineering skill.

In a similar way, Tom Campbell started as a chemist and metallurgist at Chuquicamata and advanced through the ranks to his present position as vice president of the Anaconda Co.

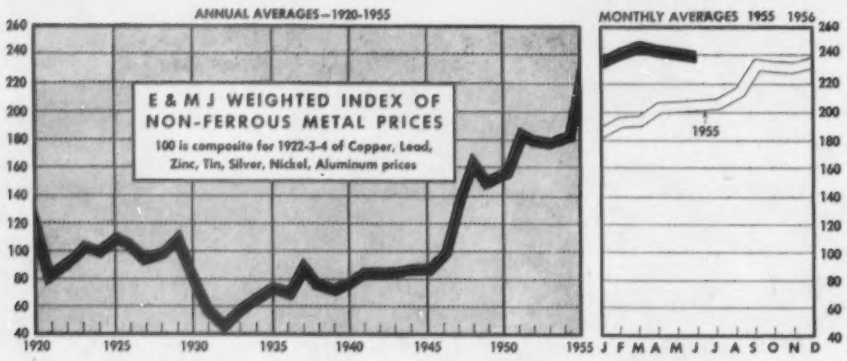
Charles Brinckerhoff graduated from the Columbia University School of Mining, started in the mining department at Inspiration, and has risen through various operating and managerial positions to his new office in South America.

These promotions to high office show that Anaconda and its subsidiaries have a high regard for engineers. But engineering ability is not enough. If these men had not widened the scope of their interest to include such human engineering problems as labor negotiations, community health and welfare, staff organization, and public relations, their ceilings might have been more limited. If they had not expanded their working knowledge to include practical principles of taxation, mineral economics, corporate finance and structure, and cost control, their rise might have been slower.

So if an engineer wants to move out of the so-called "dime-a-dozen" class, he must realize that his educatien does not stop with a diploma. His scope of interest must move beyond a technological ceiling and enter the domain of managerial headaches. To receive responsibility he must be capable of handling it—and that takes initiative and preparation (often on his own time).

E&MJ OUTLOOK

PRICES



MARKETS

E&MJ's metal price index slid off 1.77 points during June from 244.35 for May to 242.58 for June. Declining copper price was the chief cause. Lower tin and silver prices contributed slightly. This is the third consecutive monthly drop from the all-time peak of 248.28 in March.

AT HOME

Threat of substitution of aluminum for copper is building up. Midwest heavy industry manufacturers have been deeply concerned over the past instability of the copper price and supply picture. Building contracts have been let in which aluminum bus bars valued in terms of tens of thousands of dollars will be installed instead of copper, even though the substitution required redesign of conduits to handle the greater volume of aluminum conductors.

Steady improvements in alloy and fabricating techniques will increase demand for titanium sponge rapidly. As June closed, Du Pont dropped its Grade A-1 sponge price from $3.25 to $3.00 per lb.

Kennecott's Ray Mines Division plans to increase annual copper production from the 50,000-ton 1955 level to about 70,000 tons by 1958. Western Knapp Engineering Co. has been awarded the contract for the smelter at Hayden, Ariz. This is part of Ray's $40-million expansion program.

Foote Mineral Co. will spend about $2-million to expand production facilities at its Electromanganese Division, Knoxville, Tenn. Expansion will help satisfy increasing demand for electrolytic manganese in low-nickel stainless steel.

The Louisiana legislature voted for the second time on the proposed increase in the state sulphur severance tax, and it failed by a vote of 61 for—36 against. (Two-thirds is required for passage.) The second vote was on the basis of $2 per ton, an amendment to the $2.75 tax of the earlier bill.

LABOR

Last month this column said July news would tell whether the new Mine-Mill labor contracts in the copper industry would involve a total package in the 20c or 30c range. See page 125 for the answer.

ABROAD

The Philippine Congress has extended the Emergency Gold Mining Assistance Act for two years, until June 30, 1958. Subsidy privileges have also been extended to four base metal mines producing gold as a by-product, Atlas Consolidated, Lepanto, Masara and Paracale Gumaus.

World Bank's $80-million loan to the Federation of Rhodesia and Nyasaland to develop power on the Zambesi River will ultimately supply 1.2-million kw to Northern Rhodesia's expanding copper producers.

Dominion Gulf, subsidiary of Gulf Oil Corp., has applied airborne magnetometer exploration methods used for oil to the search for minerals, and come up with discovery of a major area of columbium mineralization 17 miles northeast of Chapleau, Ontario. Some 16,000 ft of diamond drilling have confirmed importance of the deposit.

London Copper Prices Fall to 32.9c
U. S. and Foreign Metal Markets Ease

ECONOMIC ACTIVITY IN JUNE remained at a high level but there are indications it was less than May. The Federal Reserve Board's index of industrial production for May, preliminary, was 142% of the 1947-49 average, one point under the revised figure for April.

The *E&MJ* index of non-ferrous metal prices dropped in June to 242.59% of the 1922-24 average from 244.35 in May. The fall in copper from 45.53c to 45.06c was largely responsible though the drop in silver and tin had some effect.

STEEL labor-management negotiations broke down. Whether the strike is protracted or not, most observers say a price rise of about $10, about 10% is certain. Steel spokesmen have indicated such a price rise follows not only from the increased costs associated with a rise in labor costs but the need to obtain funds for expanding plant. In considerable part this depends on the level of profits after taxes.

Since steel is an important "ingredient" in so much of industrial production, the strike is bound to have depressing effects on activity in other industries. Firms using much steel that have low inventories will almost immediately begin reducing operations. As a steel strike is extended more firms will move into this category—a strike of a month's duration would have drastic effects on industry.

COPPER, as far as the underlying conditions are concerned, is unchanged. The price in Europe continues to fall and market conditions here get weaker. The statement made here two months ago can well be quoted again: "They (copper prices) went high because of the shortage of supply relative to demand; presumably they will stop falling when the present reverse situation is over, when demand is no longer short relative to supply. . . . price drops can continue until they (prices) get into the neighborhood of costs for the high cost producers—then production cut-backs may take over." Up to the present, the conditions making for a price fall continue. There are no indications these will change in the next few months. The competitiveness of the copper fabricating industry and the prices at which European fabricators can sell here will lead to mounting pressure for copper price cutting in the U. S. Observers point out the U. S. copper producers have long held copper to be over-priced and by implication that there is much room for the price to drop.

Rhodesian Selection Trust companies reduced their price to £300, about 37½c a lb, effective Monday, June 18. They dropped to £275, about 34⅜c, on July 2.

U. S. custom smelters are still pricing most of their copper at about 40c (July 2).

Dealers in the U. S. have not been doing much business in copper. Recently in Europe the premium over the LME price for wire bars has been about 1½c. Dealers are willing to sell in the U. S. at several cents under the custom smelter price of 40c, but the uncertainty of European prices and the fluctuations in the premium for specifiable shapes means they often need to ask nearly 5c over the LME. Sometimes this is reduced to 3c and perhaps even less.

STRIKES occurred during the month in Rhodesia and Chile. N'kana, Mindola, and N'changa, all parts of the Rhokana group of mines, were on strike. The African workers were dissatisfied with the transfer of some workers to higher categories which lead to their transfer to another union. After three or four days they returned to work. African workers at N'changa either remained out or struck soon after. This lasted only a few days. No significant amount of copper was lost.

Locomotive workers at Chuquicamata struck for a few days.

Phelps-Dodge, Anaconda, AS&R and Kennecott reached agreements with the Mine-Mill union. They are three-year contracts calling for about 25c in wage increases with about 10c for the first year. There are considerable increases in the fringe benefits.

THE U. K. BOARD OF TRADE announced July 2 it would sell 36,000 long tons of copper it has in stock.

Copper fabricator statistics for the U.S. follow:

	March	April	May
Shipments	135,746	118,839	122,393
(a) Receipts	141,590	139,927	140,727
(a) Stocks	392,143	413,979	435,083
(a) On order	140,348	135,071	131,023
Unfilled orders	291,465	266,239	249,352
Sales	144,897	93,613	105,506

(a) Refined copper. The other data refer to fabricated products.

Copper Institute data in short tons, for April and May follow:

United States

Production:		April	May
Crude, primary	(a)	95,499	96,880
Crude, secondary	(a)	13,780	17,431
Totals	(a)	109,279	114,221
Refined copper		140,032	142,445
Deliveries, refined		139,927	140,727
Stock at end, ref'd.		54,887	53,443

Outside United States

Production:			
Crude, primary	(a)	137,487	138,146
Crude, secondary		936	1,133
Totals	(a)	138,423	139,279
Refined copper		114,430	124,106
Deliveries, refined		102,317	113,144
Stock at end, ref'd.		183,238	195,922

(a) Corrected figures.

LEAD continued to be priced in the U. S. at 16c New York. Sales to consumers of refined metal were not heavy, reflecting the decrease in activity. The U. S. Government is preventing a price fall through its purchase of foreign lead in its agriculture barter programs, and by its domestic lead buying through GSA. However, the industry was interested in the failure of GSA to purchase some of the lead offered by U. S. producers this month.

Lead producer statistics issued by the American Bureau of Metal Statistics for April and May follow:

	April	May
Stock, beginning	52,089	53,958
Production	52,976	47,961
Total supply	105,065	101,919
Shipments:		
U. S. Consumers	44,986	40,703
Exports	644	546
(a) Other	5,477	10,210
Total	51,107	51,459
Stock at end	53,958	50,460

(a) Presumably U.S. Government

ZINC remained at 13½c East St. Louis all month. Sales have been slow but the price has been held up by U. S. Government buying of foreign metal through its barter program and domestic zinc through GSA. The past month GSA did not take all the zinc it was offered. If the steel strike is prolonged, the market is expected to weaken further—many analysts believe the Government "support" buying will prevent a price fall anyway.

American Zinc Institute data for April and May follows:

	April	May
Stock at beginning	40,038	47,907
Production	88,664	81,238
Production daily rate	2,955	2,620
Shipments:		
Domestic	74,788	59,085
Export & drawback	1,437	287
Government acc't.	4,570	10,196
Totals	80,795	69,568
Stock at end	47,907	59,577
Unfilled orders	46,106	34,003

ALUMINUM markets are easier. Secondary prices are less than primary. Demand is down somewhat and production is increasing. May primary output was 150,800 tons. Alcoa is negotiating with the Steel union—the contract expires July 31. Last year there were two primary price increases, the second one following the higher costs arrived at in the labor negotiations.

TIN prices changed little during the month though they are lower than in May. President Eisenhower signed the bill permitting operation of the Texas City smelter until Jan. 31, 1957. The Government is expected to press for bids on its sale.

QUICKSILVER weakened during the month. There is considerable uncertainty. Some factors believe the sale of 10,000 flasks to the U. S. Government by an Italian producer will strengthen the market.

MARKETS *(Continued)*

Average Prices June (E&MJ Quotations)

Copper:	
Electrolytic, domestic refinery	45.056
Electrolytic export refinery	43.118
Lead:	
Common, New York	16.000
Common, St. Louis	15.800
Silver and Sterling exchange:	
Silver, New York, per oz.	90.464
Silver, London, pence per oz.	78.625
Sterling Exchange, "Checks"	280.217
Zinc:	
Prime, Western, East St. Louis	13.500
Prime, Western, delivered (g)	14.000
Tin:	
New York Straits	94.635
New York, 99% min. (e)	93.635
Gold, per oz. U. S. price	$35,000
Quicksilver, per flask	265.231
Antimony (*E&MJ*) (d))	36.470
Antimony, bulk, Laredo	33.000
Antimony, in cases, Laredo	33.500
Platinum, refined, per oz.	$105.000
Cadmium (a)	170.000
Cadmium (b)	170.000
Cadmium (c)	170.000
Aluminum, 99% plus ingot	25.900
Magnesium, ingot	33.750
Nickel (f)	64.500

Domestic quotations, unless otherwise stated, are in cents per pound. Sterling exchange checks, in cents. Quicksilver, per flask of 76 lb.

(a) Cadmium average based on the producers' quotations.

(b) Cadmium average based on the average of the producers' and platers' quotation.

(c) Cadmium average based on platers' quotation.

(d) Domestic, 5 tons or more but less than carload lots, packed in case f.o.b. New York.

(e) Tin content.

(f) F.o.b. Port Colborne, U.S. duty included.

(g) Delivered where freight exceeds 0.5c.

"Free" Gold Market

Trade volume in June rose 4½%. Paris sales were active, with a high for the year for bar gold. West Germany authorized gold coin imports. South American markets showed coins and bars rising; African trading increased with continued political unrest; Asiatic markets were brisk, with bar gold in Bombay rising to the highest price on the globe. One small soviet gold shipment in Sudan was reported. Pick's World Currency Report quotes on "free gold" per fine oz as follows:

	COINS		BARS (12.5 kg)	
	May 31	June 30	May 31	June 30
NEW YORK, transit	.....	.....	$35.08	$35.08
MANILA	$43.00	$43.25	36.15	36.10
HONG KONG	43.00	43.30	38.05	38.00
BOMBAY	55.50	57.00	54.00	55.00
TANGIER	42.15	42.35	34.92	34.88
BEYROUTH	42.75	43.05	35.12	35.12
PARIS	43.20	44.00	35.60	36.10
BUENOS AIRES	40.85	40.25	35.50	35.95

Note: Prices are computed at the free or black market value of the U. S. dollar in the local markets.

Major Metals

U. S. DAILY AND AVERAGE PRICES

June 1956	Electrolytic Copper (a) Domestic	Electrolytic Copper (b) Export	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Primary Pig 99%	Straits Tin New York
1	45.350	39.950	16.000	15.800	14.000	13.500	24.000	93.750
2	No Market	39.950	16.000	15.800	14.000	13.500	24.000	93.750
4	45.450	40.450	16.000	15.800	14.000	13.500	24.000	93.625
5	44.300	43.300	16.000	15.800	14.000	13.500	24.000	95.125
6	44.500	41.550	16.000	15.800	14.000	13.500	24.000	94.125
7	44.150	41.250	16.000	15.800	14.000	13.500	24.000	93.875
8	44.600	40.175	16.000	15.800	14.000	13.500	24.000	94.250
9	No Market	40.175	16.000	15.800	14.000	13.500	24.000	94.250
11	45.200	41.925	16.000	15.800	14.000	13.500	24.000	94.000
12	45.000	40.000	16.000	15.800	14.000	13.500	24.000	94.625
13	44.625	42.400	16.000	15.800	14.000	13.500	24.000	94.375
14	44.700	42.850	16.000	15.800	14.000	13.500	24.000	95.000
15	44.950	40.750	16.000	15.800	14.000	13.500	24.000	95.500
16	No Market	40.750	16.000	15.800	14.000	13.500	24.000	95.500
18	44.900	41.725	16.000	15.800	14.000	13.500	24.000	94.750
19	45.250	40.875	16.000	15.800	14.000	13.500	24.000	94.750
20	45.075	40.400	16.000	15.800	14.000	13.500	24.000	94.750
21	45.475	38.525	16.000	15.800	14.000	13.500	24.000	94.875
22	45.375	39.900	16.000	15.800	14.000	13.500	24.000	95.375
23	No Market	39.900	16.000	15.800	14.000	13.500	24.000	95.375
25	45.450	40.450	16.000	15.800	14.000	13.500	24.000	95.125
26	45.350	39.900	16.000	15.800	14.000	13.500	24.000	94.625
27	45.450	38.825	16.000	15.800	14.000	13.500	24.000	95.000
28	45.500	38.525	16.000	15.800	14.000	13.500	24.000	94.875
29	45.525	36.125	16.000	15.800	14.000	13.500	24.000	94.625
30	No Market	36.125	16.000	15.800	14.000	13.500	24.000	94.625
AVERAGES FOR MONTH								
June	45.056	40.260	16.000	15.800	14.000	13.500	24.000	94.635
AVERAGES FOR WEEK								
June								
6	44.960	41.038	16.000	15.800	14.000	13.500	24.000	94.083
13	44.719	40.988	16.000	15.800	14.000	13.500	24.000	94.229
20	44.975	41.225	16.000	15.800	14.000	13.500	24.000	95.042
27	45.420	39.583	16.000	15.800	14.000	13.500	24.000	95.063
CALENDAR WEEK AVERAGES								
June								
2	45.400	40.733	16.000	15.800	14.000	13.500	24.000	94.400
9	44.600	41.150	16.000	15.800	14.000	13.500	24.000	94.208
16	44.895	41.446	16.000	15.800	14.000	13.500	24.000	94.833
23	45.215	40.221	16.000	15.800	14.000	13.500	24.000	94.979
30	45.455	38.325	16.000	15.800	14.000	13.500	24.000	94.813

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

June 1956	Silver (c) New York	Silver London	Sterling Exchange "Checks"	Gold London	Gold (d) United States
1	90.750	79.000d.	280.3125	249s. 7d.	$35.00
2	(e)	(e)	(e)	(e)	35.00
4	90.750	79.000d.	280.0982	249s. 7¼d.	35.00
5	90.750	79.000d.	280.0446	249s. 9½d.	35.00
6	90.750	79.000d.	280.1696	249s. 9¼d.	35.00
7	90.750	79.000d.	280.3616	249s. 8d.	35.00
8	90.750	79.000d.	280.4062	249s. 5¼d.	35.00
9	(e)	(e)	(e)	(e)	35.00
11	90.750	79.000d.	280.4553	249s. 6d.	35.00
12	90.750	78.875d.	280.5000	249s. 6d.	35.00
13	90.500	78.750d.	280.5848	249s. 4½d.	35.00
14	90.500	78.500d.	280.5000	249s. 4¾d.	35.00
15	90.250	78.500d.	280.4508	249s. 5d.	35.00
16	(e)	(e)	(e)	(e)	35.00
18	90.250	78.125d.	280.4687	249s. 5¼d.	35.00
19	90.250	78.125d.	280.4866	249s. 5¼d.	35.00
20	90.250	78.125d.	280.4151	249s. 5d.	35.00
21	90.250	78.375d.	280.2589	249s. 7d.	35.00
22	90.250	78.375d.	280.2500	249s. 8d.	35.00
23	(e)	(e)	(e)	(e)	35.00
25	90.250	78.375d.	280.1250	249s. 7d.	35.00
26	90.250	78.500d.	279.9285	249s. 9¾d.	35.00
27	90.250	78.500d.	279.4062	249s. 11¼d.	35.00
28	90.250	78.500d.	279.5357	250s. 2¼d.	35.00
29	90.250	78.500d.	279.8035	250s. ¾d.	35.00
30	(e)	(e)	(e)	(e)	35.00
AVERAGES FOR MONTH					
June	90.464	78.625	280.217	—	35.00
AVERAGES FOR WEEK					
June					
6	90.750	—	280.177	—	35.00
13	90.700	—	280.462	—	35.00
20	90.300	—	280.464	—	35.00
27	90.250	—	279.994	—	35.00

Calendar Week Averages: New York Silver: June 2nd, 90.750; 9th, 90.750; 16th, 90.550; 23rd, 90.250; 30th, 90.250.

(e) No Market (Saturday).

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.300c per pound, the average differential for delivery charges.

(b) Our export quotations for copper reflects prices obtaining in the open market and is based on sales in the foreign market reduced to the f.o.b. refinery equivalent, Atlantic seaboard. On f.a.s. transactions we deduct 0.075c for lighterage, etc., to arrive at the f.o.b. refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West, and West, effective Jan. 1, 1951, commanded a premium of 1.35c per pound over the current market for Prime Western; Special High Grade 1.75c effective Dec. 1, 1955.

(f) Prime Western delivered where freight from E. St. Louis exceeds one-half cent.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 pounds.

(c) The daily silver quotation reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually one quarter cent below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5 per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U.S. Treasury's gold price. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

London Metal Exchange Quotations

June	COPPER Cash Bid	COPPER Cash Asked	COPPER 3 Mo. Bid	COPPER 3 Mo. Asked	LEAD Current Month Bid	LEAD Current Month Asked	LEAD 3 Mo. Bid	LEAD 3 Mo. Asked	ZINC Current Month Bid	ZINC Current Month Asked	ZINC 3 Mo. Bid	ZINC 3 Mo. Asked	TIN Cash Bid	TIN Cash Asked	TIN 3 Mo. Bid	TIN 3 Mo. Asked
1	294½	295	292½	293	109⅝	110	107	107¼	91¼	91¾	89½	89¾	723	724	723	724
4	295	295½	295½	296	109¾	110	107	107½	91¾	92	89¾	90	724	725	723½	724
5	304½	305	304½	305	110¼	110½	107½	107⅝	92	92½	90¼	90½	729	730	727½	728
6	314	316	315	316	112	112¼	110	110¼	92⅝	93¼	91¼	91¾	735	735½	732½	733
7	302½	303½	305	306	111½	111⅝	109⅝	110	91¾	92¼	90¼	90½	730	732	729	730
8	298½	299	300	301	111¼	111½	109½	109⅝	93	93¼	90⅝	91¼	735	736	732½	733½
11	297½	298	299½	300	112¼	112½	110	110½	94½	93⅝	92⅝	93	736	736½	732½	733
12	307	308	308	309	113	113¼	111	111¼	95½	95⅝	93½	94	737	738	733	734
13	311½	312	312	313	117	117½	114½	114⅝	98½	99	96¼	96½	743	744	738	739
14	301	301½	302	302½	116¼	116½	113½	113⅝	96	96¼	94½	94¾	745	746	741	742
15	303	303½	303	303½	116	116¼	113½	113⅝	96	96¼	94¼	94½	753	755	749	750
18	299	300	299	300	114½	115	112½	112⅝	94⅝	95¼	93¼	93¾	748	750	742	743
19	294	294½	295	295½	113½	114	111⅝	112	94½	94¾	92⅝	93	748½	749	739	740
20	294	294½	295	295½	113	113¼	111¼	111½	94¼	94½	92½	92¾	749	750	740	741
21	293½	294	295	296	113⅝	114	112	112⅜	94	94¼	92⅜	93	755	756	745	746
22	293½	294	295	295½	115	115¼	113	113⅜	94¼	94½	92⅝	93¼	755	756	745	746
25	289	289½	292	293	114¼	114⅝	112½	112⅝	94	94¼	92⅝	93	753	754	743	744
26	289½	290	292½	293	114⅛	114½	112⅛	112½	94¼	94½	92⅝	93¼	747½	748	739	740
27	287½	288½	292	292½	113½	113⅝	111½	112	93¾	94	92½	92¾	747	748	739	740
28	283	285	287½	288	112¼	112½	110¼	110½	92	92¼	90¾	91	742	744	739	741
29	274	275	277	278	111½	112	109¼	109½	92	92½	91	91¼	738	739	735	736
Av'g's	£296.857		£298.310		£113.226		£111.071		£94.006		£92.387		£742.190		£736.952	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.97%, zinc 98% and tin min. 99.75%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments f.o.b. New York unless otherwise stated, tons of 2,000 lb unless otherwise noted. St—short ton, lt—long ton.

MISCELLANEOUS METALS

June 30, 1956

Aluminum ingot, 99 plus % lb			25.9¢
Antimony, spot, lb, less than carload, in cases			36.47¢
In bulk, carload lots, f.o.b. Laredo			33.00¢
Bismuth, ton lots, lb			$2.25
Cadmium, commercial sticks, delivered, lb			$1.70
Calcium, lb, ton lots, 98%, cast			$2.05
Chromium, 97% grade, lb, contract			$1.25
Cobalt, 97 to 99%, per lb			$2.60
Germanium, per gram, 10,000 gram lots	44½¢	@	48½¢
Indium, troy oz			$2.25
Lithium, lb, 98%	$11.00	@	$14.00
Nickel, cathodes, lb, f.o.b. Port Colborne (a)			64½¢
Magnesium, 99.8%, carloads, lb, producer's plants, Velasco, Texas, Eff. Apr. 16			33½¢
Palladium, troy oz	$23.00	@	$24.00
Platinum (wholesale lots) troy oz	$103	@	$110
Quicksilver, flask of 76 lb, 25 flasks or more	$256	@	$258
Selenium, 99 plus %, lb. (Feb. 1)			$13.50
Silicon, minimum 97%, carloads, lb			20½¢
Tellurium, lb	$1.50	@	$1.75
Thallium, 100 lb or more, lb			$12.50
Titanium, 99.3 plus, grade A-1, max. 3% iron, lb			(b)$3.25

(a)Includes U. S. duty. (b)Effective May 14, 1956.

METALLIC ORES

Beryllium Ore, imported, 10% BeO, per short ton unit	$36.00	@	$38.00
Chrome Ore per long ton, f.o.b. cars Atl. ports, dry:			
44% Cr_2O_3 no ratio	$24.00	@	$25.00
48% Cr_2O_3 3 to 1 ratio	$45.00	@	$54.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:			
Old Range bessemer			$11.25
Mesabi bessemer			$11.00
Mesabi, non-bessemer			$10.85
Lead (Galena), 80%, Joplin, Mo., ton			$201.32
Manganese Ore—Per long ton unit of Mn basis 48% manganese, nearby positions, subject to premiums and penalties $1.30 @ $1.35 c.i.f. U. S. ports, duty extra, nominal. Long-term contract nominal.			
Molybdenum Ore, 90%, per lb of Mo f.o.b. mines	$1.10	@	$1.15
Columbium-Tantalum, per lb, combined oxides	$1.15	@	$1.35
Tungsten Ore, per unit of WO_3:			
Foreign 60%, c.i.f. U. S. ports, duty extra	$33.00	@	$33.50
Domestic, scheelite, 60% f.o.b. mill			$63.00
Vanadium Ore, per lb of contained V_2O_5 f.o.b. mines			31¢
Zinc Ore, Prime, 60% concentrate, Joplin, Mo., per ton			$84.00

(a) Nominal. (b)Corrected.

METALLIC COMPOUNDS

Arsenous Oxide (arsenic trioxide) lb, in bbl carload lots delivered			5¼¢
Cobalt Oxide, 72½% to 73½%, ceramic grade, per lb	$1.96	@	$1.98½
Copper Sulphate, 100 lb			$16.70
Germanium Oxide, gram			27½¢
Molybdic trioxide, technical, per lb of Mo	$1.30	@	$1.35

ALLOYS

Ferrochrome 65 to 70%, per lb of Cr. (4-9% C)			26½¢
Ferromanganese, 74 to 76%, per lb., shipg. pt			10.75¢
Ferromolybdenum, 58 to 64% Mo, lb of Mo contained	$1.54	@	$1.66
Ferrosilicon, 50% per lb of Si f.o.b. shipping point			12¾¢
Ferrotungsten, 72 to 82%, lb of W contained (eff. Feb. 1)			$3.45
Ferrovanadium, per lb of V delivered	$3.10	@	$3.30
Silicomanganese, max. 1½% carbon, lb, contracts			12¢
Spiegeleisen, per long ton, 19 @ 21% grade			$96.00

NON-METALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (U. S. funds) ton:			
Crude No. 1	$1,400	@	$1,725
Crude No. 2	$750	@	$1,100
Spinning fibers	$350	@	$650
Shingle fibers	$190	@	$210
Paper stock	$114	@	$137
Waste	$82	@	$84
Shorts	$28	@	$75
Asbestos, f.o.b. Vancouver, B. C. (U. S. funds):			
Spinning fiber	$460	@	750
Shingle fiber, effective Jan. 1	$205	@	$300
Asbestos, Vermont, f.o.b. Hyde Park:			
Spinning fibers	$353	@	$383
Shingle stock	$172	@	$190
Paper stock	$114	@	$145
Waste, stucco or plaster	"		$82
Refuse or Shorts	$39	@	$72
Barytes f.o.b. cars:			
Georgia, crude, per ton			$18
Missouri, 94% $BaSO_4$, per short ton			$16
Crude oil well grade, min. 4.3% sp gravity, at			$11.50
Bauxite, long ton, f.o.b. point of shipment:			
Domestic crude, 50 to 52% (not dried)	(a)$5.00	@	$5.50
Domestic, chemical, 55 to 58%	(a)$8.50	@	$9.05
Domestic, abrasive, 80 to 84%	(a)$18.00	@	$18.50
Imported metallurgical, per lt, job Br. Guiana, dep. on grade	$6.00	@	$7.00
Feldspar, bulk ton:			
Potash or soda feldspar, 200 mesh, ceramic grade	$18.50	@	$22.25
Glass feldspar, white, 20 mesh	$11.75	@	$12.50
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$33	@	$35
60% effective CaF_2	$28	@	$30
Acid 97% concentrate, bulk, ton			$47.50
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00	@	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington			$40.00
Mica—Domestic, f.o.b. mines. Punch 7¢ to 12¢ per lb according to size and quality. Sheet clear, 1½ x 2-inch, 70¢ to $1.10; 2 x 2-inch, $1.10 to $1.60; 2 x 3-inch, $1.60 @ $2.10; 3 x 3-inch, $1.80 @ $2.30; 3 x 4-inch, $2.00 @ $2.60; 3 x 5-inch, $2.60 @ $3.00; 4 x 6-inch, $2.75 @ $4.00; 6 x 8-inch, $4.00 @ $8.00. Wet ground, very fine, $140 @ $155 per ton. Bulk sales, dry ground: $32.50 @ $70.00 per ton. Scrap $25 and up.			
Ocher, Georgia, ton, in sacks	$26.50	@	$30.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports			Not quoted
Sulphur, per lt, job U. S. mines: bright			$26.50
dark			$25.50
Talc, f.o.b. works, ton:			
New York, purified	$18.50	@	$20.00
Vermont, extra white			$12.50
Tripoli, Missouri, ton:			
40-mesh, cream colored			$50.00

(a) Nominal.

IRON AND STEEL

Pig Iron, gross ton, basic, Valley Furnaces			$58.50
Steel f.o.b. Pittsburgh, billets, net ton			$68.50
Structural shapes, Pa., Ala. etc., 100 lb	$4.50	@	$4.60

Summer Fever Sparks British Columbia

MINING ACTIVITY in the southern sector of British Columbia this month featured:

1. Silver Hill Mines Ltd., which resumed work on its 24-claim group on Treasure Mountain near Hope.

Work on the property was suspended last November due to severity of winter conditions.

Present work includes building a loading ramp at Tulameen and putting the road to the mine in shape. At the mine work will be centered on preparing mill and mine for production as soon as possible.

2. A deal between Cariboo Gold Quartz Mining Co., Ltd. and Kelowna Hedly Exploration Co. will bring back to production one of British Columbia's oldest gold mines.

Cariboo has acquired part of the old Nickel Plate mine at Hedly from Kelowna Hedly for $15,000 cash plus a guarantee that $50,000 will be spent in the next year-and-a-half to get the mine into production.

Under the deal Cariboo gets 12 claims known at the "French" Mine. Cariboo president Dr. W. B. Burnett, said a geological survey has indicated good grade ore is in place and that a better than average chance exists for finding new deposits.

3. Canam Copper Mines Ltd., 26 miles east of Hope has reported exposure of its orebody for 3500 feet. Development work is being handled with a 50-man crew, and milling plans are being considered as the development program proceeds.

4. Foundation Mines Ltd., recently-formed B.C. mining company, will start exploratory work shortly on a base metals property on the Hope-Princeton Highway, in the same area as Canam Copper.

The company was initiated by Vancouver interests headed by Nicholas Massalem, president. Consulting geologist is Alfred R. Allen.

Mussallem, said his company will start diamond drilling a nickeliferous pyrrhotite deposit situated on the company's 16-claim group. At the same time, it will carry out development work of a fissure vein occurring in a section of the property and reported to contain gold, silver, lead and zinc.

5. Highland-Bell Ltd. will spend $133,000 to prepare its new low-level source of good grade silver ore for mining with the expectation that it will be ready to supply the present 55-to-60 tons daily mill by the end of the year, president K. J. Springer said this month in Vancouver.

He said decision on a possible increase in mill capacity would await opening up of the new ore, and that there was a good chance the new mine would warrant mill expansion.

Springer said new ore prospects suggest several years of life ahead of the operation, and added that exploration will be put on a permanent basis. The company will continue to search for other properties.

The mill is still operating at capacity with ore from the old mine.

6. Howe Sound Co., which operates Britannia Mining and Smelting Co., at Britannia Beach, reports its 1956 first-quarter earnings of $810,000 are double that of the same period in 1955.

Harold H. Sharpe, company president, said the increased earnings reflected a favorable market for metals produced by the company throughout the first quarter. He added, however, that since April 1 "there has been some weakening in foreign markets for copper, lead and zinc, which has reflected the fact that the supply of the metals is more closely in line with demand than has been the case for some months."

7. New Santiago Mines Ltd. reports drifting and diamond drilling has been resumed at its New Denver, B.C. property. This work is being carried out on the sixth and seventh levels of the mine.

Rehabilitation of the lower levels of the Bonnie prospect near Princeton is scheduled to start soon. Golden Slipper Mines Ltd. will participate with New Santiago in this work. Application to lease several other properties is pending.

8. Plans for a vigorous development program are outlined in the first annual statement by Mid-West Copper and Uranium Mines Ltd.

Company president M. F. Maxwell said the company is concentrating its efforts on the Velvet Mine near Rossland.

He added that plans are finalized to bring the property into production at an early date concurrent with the erection of a mill the company purchased during the year.

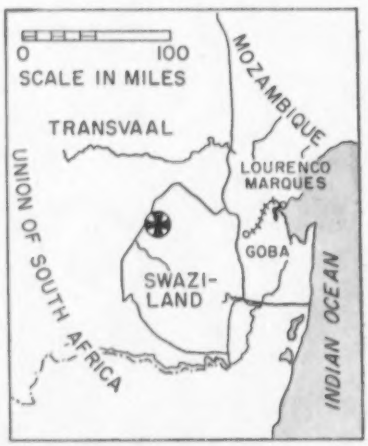
Mid-West which was organized last May, holds claims in the Windermere Valley also. Dr. A. G. Pendland is consulting geologist.

9. Salmo Prince Mines Ltd. reports important developments and progress at both its exploration projects.

At its Greyhound property at Greenwood where exploration now is under direction of Newkirk Mining Corp., the program is to be intensified. In addition to continuing diamond drilling, it is proposed to open up the old 220-foot deep shaft and to carry out bulldozing stripping. A geophysical survey will be made of all 32 claims.

Exploration is proceeding steadily on Salmo Prince's 24 claims in the Wildcat Group in the Highland Valley area, and the company expects to complete purchase of other claims doubling its holdings in the area.

Swaziland Totes Up Fe Reserve



THE BRITISH PROTECTORATE of Swaziland in southeast Africa may have a proven reserve of about 45-million tons high grade iron ore when current drilling reports are published in March 1957.

Deposit was first announced early this year (*E&MJ*, February 1956, p 224) and surveying and drilling began in the tiny protectorate near the southern tip of Mozambique almost immediately. A similar investigation of coal deposits has shown rich results, leading to some speculation about the future building of a smelter.

Biggest obstacle to development of the mine will soon be overcome with the construction of a rail line to Goba, Mozambique, which is already connected with the port of Laurenco Marques on the Indian Ocean. Only other mining venture in Swaziland is the Havelock Asbestos property, also in the northern part.

The Geological Survey Department at Mbabane lists the following estimated mineral reserves of Swaziland: (in short tons)

Asbestos	1-million, based on present production
Andalusite ...	30,000*
Barytes	1-million*
Calcite	10,000**
Coal	10-million***
Diaspore	30,000*
Fluorspar	100,000***
Gold	50,000 oz.***

Iron Ore ..... 40- to 50-million* expected to be proved by current drilling.
280-million low grade, figure based on geology.

* proved by diamond drilling
** estimated by excavation
*** estimated from geological knowledge.

The coal and iron ore figures may be changed following the current survey, with some observers expecting drastic revisions upward. Several British, U. S. and South African companies have reportedly made inquiries. Grade of high value hematite iron ore has been set at 64% Fe.

Official Calls Bikita Ores Among Largest and Richest

DEPOSITS of lepidolite and petalite t Bikita in Southern Rhodesia have proved to be large and possibly among the richest in the world, according to W. Ralston, chief government mining engineer, in an official report published last month. The report notes that lithium metal is not yet being produced in Southern Rhodesia though some of the present small local output is being processed at Gwelo in Southern Rhodesia for the production of lithium salts.

In 1955 82,166 tons of lithium ores were mined in Southern Rhodesia at a total value of £328,529, ($900,000).

Sierra Leone to Boost Output

THE PRIVATE COMPANY, Sierra Leone Development Co., has announced plans to spend $42-million to boost iron ore output from 1.3-million to 3.6-million tons a year. Over $16-million of the money will come from Sierra's own treasury, with the rest to be raised outside. Chances are that this will make Sierra a public-holding company.

Jobs Open for Engineers

U. S. BUREAU OF LAND MANAGEMENT is looking for experienced mining engineers and geologists to fill career positions, as a result of newly enacted legislation designed to expand Land Management's mineral development program. Biggest job for Land Management under the new legislation (Public Law 167 in this case) is administering multiple-use-of-surface-resources. BLM has to examine all unpatented claims on unreserved land and determine surface rights in 11 Western states and Alaska.

Salaries start at $4,525 and go to $7,570, with most openings in GS-9 and GS-11 at $5,550 to $6,390. If interested write to Placement Officer, Department of Interior, Bureau of Land Management, Washington, D. C.; or to local Land Management offices in Portland, Ore.; Salt Lake City; Denver; and Juneau, Alaska.

As we went to press . . . .

John B. Knaebel, who found and developed Anaconda's Jackpile and Bluewater, has been named assistant to the vice president (mining operations) and will move to the New York office of Anaconda Co.

According to the will probated in San Mateo County Court, Daniel C. Jackling's estate (about $7-million) will be held in trust for Mrs. Jackling; then distributed to charities, churches and colleges (to establish loans for engineering students).

Speaking before the Denver Research Institute, University of Denver, Jesse C. Johnson, Director, Division of Raw Materials, U. S. AEC, said that the $8 a lb price established for U_3O_8 was based on past experience and could be raised or adjusted if necessary to get needed production during 1962 to 1966. He also announced a reorganization of AEC field activities west of the Mississippi. All exploration will be directed by Grand Junction under Elton A. Youngberg, assistant director for operations. Denver and Salt Lake are now branches reporting to Youngberg at Grand Junction.

Shaft-sinking is underway on Lisbon Uranium's 600-ft, two compartment shaft in the Big Indian, under direction of Gene Bishop, Inc., Golden and Grand Junction, Colo. See Colorado news.

Basic Atomics, Inc., Lincolnton, N. C., announced lithium ore reserves at 11-million tons on some 1900 acres in Lincoln County. Company has test lab and plans pilot mill. Future plans call for processing plant at Lake Sylvia.

Bear Creek Mining Co., Kennecott Copper Corp. subsidiary, will sink a 1000-ft, multi-compartment shaft in East Tintic district, following approval of a 10,000 acre unit-development contract between Bear Creek, Tintic Standard Mining Co., and Chief Consolidated Mining Co. Contract is for 50 years, with participants sharing any profit from ores developed in this lead-zinc-silver mining area. Total on-stream cost may reach $8-million.

Catalytic Construction Co., Philadelphia, has contract to build Union Carbide Nuclear Co.'s uranium processing mill at Rifle, plus contracts for upgrading units at Slick Rock and Greenriver. See page 126, this issue.

Peru's June election is still up in the air at this time. Nobody knows for sure who will be the next president. From here it looks like Manuel Prado, ex-president, will be back in office. Senor Terry provided the suspense element. He almost won the election, after predictions that he would finish a poor third. On June 26, President Odria suspended civil liberties for thirty days, following rioting and a general strike touched off by employees at International Petroleum Co., Ltd. refinery. See page 126.

Behind the By-Lines...

G. P. Lutjen

The Beaver Patrol took a hand in preparing one of this month's big articles, the world-wide survey of the oxidized copper situation. Beaver Patrol is the family name for the McGraw-Hill World News Bureau, a remarkable collection of energy and talent. Not only do these men and women keep us posted on what's going on all over the world, but they stand ready to tackle special assignments from the editors—anything from getting the flowsheet of a Samoan bead factory to an interview with the local hakim in Mesopotamia. If the story's there, the Beaver Patrol will get it.

The whole crew is what we needed when we got going on the oxidized copper story. It occurred to us, that with the higher level of copper prices and new advances in technology, there might be some profitable mining in the offing. First we wanted to know how much oxidized copper was lying around and what, if anything, has been, is being, or will be done about it. We put the question to the World News people and the Beaver Patrol came through in its usual fine style with detailed reports pouring in from 54 countries. Jim Franklin has digested, analyzed, condensed and organized the reports into a readable, fast-moving survey which you will find on pages 97 to 103.

This is only the first installment on this timely subject. Part II will take up the situation in the United States. Part III, in the hands of Nathaniel Arbiter of Columbia University, will answer the important questions of how to extract copper from oxidized material and how much it will cost. Stand by!

What has happened to this morose gent? Did he just have a straight beaten by a full house? Did somebody put too much vermouth in his martini? Is he a Giant fan?

All these guesses are wrong. In the first place, he doesn't gamble except maybe when he starts out for the beach on a cloudy morning. Secondly, he scorns martinis, and lastly, like all true, red-blooded Americans, he's a Dodger fan. Allow us to introduce F. Alvin Zimmerli, *E&MJ*'s capable layout editor, who's shown here posing for an article in *Coal Age*, our counterpart in the coal mining industry. If you look closely, you will see he's the same chap that's playing a four-way role on our cover.

In his job, Al has to be just about all those things he's depicting on the cover—"executive", "production man", "research man", "teacher". It seems editors have learned that no matter how timely or important an article may be, whether it's in a business paper or a "slick" weekly, unless the presentation of the story reflects its importance or timeliness, fewer people will read it than will vote the Whig ticket in the next election. This presentation of *E&MJ* articles is Al's job. His ultimate responsibility is to you, the reader—seeing to it that there's no chance of your getting lost in a hodge-podge of material that has simply been thrown together in a technological tossed salad.

Two depressing pieces of information came our way last month. We pass them along in the fond hope that they will disturb you as much as they have us.

In the April 27 issue of *Science*, Dr. Graham DuShane discusses a survey of the reading habits of the American people made by the American Institute of Public Opinion. Results show that only 17% of the adults were found to be reading books as compared with 55% in England, 34% in Australia and 31% in Canada. Moreover, 57% of our high school graduates and 26% of our college graduates have not read a book for the past year.

"We might suppose," says Dr. DuShane, "that even though college graduates do not read much currently, they have some background of reading, some acquaintance with 'the best that has been known and said.' The results are again disappointing. The college graduates were asked to name the authors of the following books: An American Tragedy, Babbitt, The Canterbury Tales, Gulliver's Travels, Leaves of Grass, The Old Wives' Tale, Utopia, Vanity Fair, The Origin of Species, The Wealth of Nations, The Rubaiyat, and The History of Tom Jones.

"Nine per cent could not name the author of any of these books and 39% could not name more than three authors. Of the same group of college graduates, only 55% could name any recently published book."

Our second melancholic note has to do with the newsstand sales of the nation's popular magazines. According to reports for the last 6 months of 1955, *Confidential* has the largest per issue, single copy sales ever audited. This must establish some kind of record for sleazy taste.

We had planned a devasting harangue at this point, but it will have to wait. We've got to hurry away: It's Howdy Doody time on the Idiot Box.

A Modern Metallurgical Classification System

Here is an approach to your technical problems in metallurgy that will automatically sharpen the perspective of the practical operator, the planner, the designer. It's the closest thing to a sure cure for the hamstringing effects of compartmentalized thinking yet devised. In our engineering curricula, it would simplify training of young engineers and turn out a more useful man for industry.

RAYMOND E. VENER
Catalytic Construction Corp.

WHETHER YOUR JOB is in the mill or smelter, university or research lab, whether you're an executive or a consultant, a well defined system of classifying metallurgical operations can help you by paving the way for new ideas, saving you money and making your job easier. Present classification systems used in chemical engineering fields, and to some extent in metallurgical engineering, have been rendered unsatisfactory by recent strides in technology. The proposed classification outlined on these pages will not only furnish an up-to-date tool, but is geared to accommodate any future advances in technology, whatever they may be.

Adaptability is provided by getting down to fundamentals in studying unit operations. (Unit operations are defined here, involve various combinations of bulk chemical reactions, changes of state, and state of aggregation.) These unit operations are classified under three main headings:

1. **Multi-Phase Systems**
2. **Materials Handling**
3. **Energy Transfer**

These groups may be subdivided for convenience as shown on the table on the following page. While some of the operations covered on this table hold little interest for the metallurgical engineer in our present concept of that profession, the entire framework of the classification system is shown to make it clear how any phase of processing may be fitted into the scheme. With the trend of present day technology, it is getting ever more difficult to draw a line between the realm of the metallurgical engineer and the chemical engineer. In fact, no realistic division can be made.

Multi-Phase Systems

Our primary concern here is multi-phase systems which include the unit operations of importance to men in metallurgy. In extractive metallurgy, we find that at any given point in the processing of materials, we can resolve the reaction into a consideration of two phases according to the state (liquid, gas or solid) of the materials involved. This gives us six permutations: solids-liquid, solids-gas, solids-solids, liquid-gas, liquid-liquid, and gas-gas.

Regardless of which of these two-phase systems are involved, our aim is to accomplish one or more of the following steps—mixing, contacting, or separation.

To illustrate: In preparing a charge for a sintering machine, we are concerned with mixing pulverized coal with ground ore or concentrate. The basic problem is classified as solids-solids mixing. When we ignite this mixture on the machine and force air through it, our problem is one of solids-gas contacting. Formed in this process are a sinter and a gas and we are now faced with a solids-gas separation. While this separation on the sintering machine represents no difficulties, we have a little harder solids-gas separation problem in cleaning the gas of solid particles.

Definitions of mixing and separating are self evident. For the purpose of our classification system, we are defining contacting as the providing of retention time within the contacting equipment. It is recognized that contacting and mixing are frequently carried out simultaneously in one operation and in some operations, contacting and separation occur in such close sequence that for all practical purposes they are considered as being simultaneous. But even in cases of simultaneous contacting-mixing or contacting separation, it may pay to analyze your operation as distinct contacting and mixing, or contacting and separating operations. By thus cutting your thinking loose from consideration of one traditional piece of equipment that renders these operations simultaneously, you may come up with other methods that solve the two problems separately with better over-all economy.

Some further clarification is also in order on the subject of phases. While most important commercial operations involve only two phases, more than two phases may be present. This is certainly true where several different solids species are present even though, theoretically, only solid phase is present.

In flotation where we are tackling a solids-solids separation (i.e. sulphide particles from gangue), the basic mechanism involves preferential wetting of some of the constituents with air bubbles in what is basically a liquid-gas contacting operation. Actually, one species of solids is separated from an aqueous mixture of another as a foam of gas bubbles.

In wet scrubbers of gas streams containing solid particles, the operation is primarily a gas-solids separation with liquid used as a separating medium. In slurry solvent extraction, two liquid phases and one solid are present although the

Metallurgical Classification

I MULTI-PHASE SYSTEMS

Unit Operations	Divisions	Equipment and Methods
1. Solids-Gas	Contacting	Drying
		Chemical conversion of solids
		thermal decomposition
		Sintering
		Smelting
		Sublimation
		Heterogeneous catalysis
		Heat transfer
		Adsorption
		Chemical regeneration of solids
	Separation	Gravitational settling
		inertia separation
		Centrifugal separation
		Filtration
		Electrostatic precipitation
		Scrubbing
		Agglomeration
		Sonic precipitation
	Mixing	Miscellaneous distribution arrangements
2. Solids-Solid	Contacting	Heat treatment
		Chemical reactions
	Separation	Magnetic separation
		Electrostatic separation
		Centrifugal separation
		Heavy Media separation
		Flotation
		Tabling
		Jigging
	Mixing	Tumbling
3. Solids-Liquid	Contacting	Precipitation
		Freezing
		Dissolution
		Leaching
		Chemical conversions
		Heterogeneous catalysis
		Ion exchange
		Adsorption
	Separation	Drying
		Draining
		Filtration
		Thickening
		Clarifying
		Centrifugation
		Cyclones
		Coagulating
		Wet screening
		Presses
	Mixing	Gas lift
		Gas spargers
		Paddles
		Propellers
		Helical
		Turbines
		Colloid mills
		Ball mills
4. Liquid-Gas	Contacting	Chemical reactions
		Evaporation
		Distillation and condensing
		Humidification and dehumidification
		Water cooling
		Air conditioning
		Adsorption and desorption
		Vaporization
		Flotation
		Scrubbing
	Separation	Gravitational settling
		Inertia separation
		Centrifugal separation
		Filtration
		Electrostatic precipitation
		Scrubbing
		Coalescence
		Sonic precipitation
	Mixing	Injectors
		Gas lift
		Bubblers
		Spray towers
5. Gas-Gas	Contacting	Heat transfer
		Diffusion
		Chemical reactions
	Separation	Gaseous diffusion
		Thermal diffusion
		Siphoning
		Centrifugation
		Electromagnetic methods
	Mixing	Injectors
		Jets
		Blowers
		Fans
		Baffle columns
6. Liquid-Liquid	Contacting	Solvent extraction
		Chemical reactions
		Heat exchange
		Miscible and emulsified liquids
	Separation	Centrifugation
		Settling
		Distillation
	Mixing	Jets
		Injectors
		Turbulence
		Orifice
		Centrifugal pumps
		Towers
		Paddles
		Turbines
		Homogenizers

II MATERIALS HANDLING

Unit Operations	Divisions
1. Conveying	Solids
	Slurries (liquids & gases are included under fluid flow)
2. Storing	Liquids
	Gases
	Solids
3. Measuring & proportioning	Feeders:
	Solids
	Liquids
	Gases
	Packaging & filling:
	Solids
	Liquids
4. Size reduction of solids	Crushing
	Grinding
	Cutting
	Machinery
	Flaking
	Emulsification
	Spraying
	Gas Dispersion
5. Size enlargement of solids	Sintering
	Tumbling
	Pressure
	Extrusion
	Spray
	Casting

III ENERGY TRANSFER PHENOMENA

Unit Operations	Divisions
1. Fluid flow (Momentum transfer)	Non-compressibles
	Compressibles
2. Heat transfer	Conduction
	Convection
	Radiation
	Electrically generated
	Chemical reactions
	Mechanical work
3. Electrochemistry	Electrothermal processes
	Electric melting
	Batteries
	Oxidation & reduction processes
	Electrochemistry of gases
	Power generation & use
4. Nuclear energy	Heterogeneous systems for power purposes
	Homogeneous systems for power purposes
	Chemical changes by nuclear radiation

operation is still liquid-liquid contacting.

In slurry ion exchange, solid-liquid contacting exists although at least two distinct species of solids are present.

How each of these multi-phase systems is broken down into divisions of mixing, contacting and separating, and how these in turn may be further subdivided into processes, is blueprinted on the accompanying table. To demonstrate the classification in action, a complete article on solids-gas contacting starts on page 78 of this issue.

Why a New Classification?

No system of classification would be complete unless it provided a framework for all operations involved in processing. For this reason two other important areas are included in the blueprint: materials handling, involving conveying, storing, measuring and proportioning, size reduction and size enlargement; and energy transfer phenomena, including fluid flow, heat transfer, electrochemistry and nuclear energy.

To a greater or lesser extent these are all considerations of the metallurgical engineer. Obviously, however, many are considered to be in the traditional province of the chemical engineer. But because metallurgical engineers have been directing their attention to the growing and obvious overlapping of their spheres of activity with those of the chemical engineers, a comprehensive organization of operation is needed. organization of operation is obviously needed.

Several recent books in the field have made stabs at such an approach. Most of these attempts have been made along a line parallel to the organization currently used in most chemical engineering literature and a great deal of confusion has resulted.

Originally the chemical engineering approach resolved the manufacturing processes where chemical or physical changes took place into a coordinated series of unit physical operations and unit chemical processes. Unit processes originally included fluid flow, heat transfer, distillation, absorption, drying, crushing and grinding, and similar operations, generally physical in character in their classification.

This "unit process concept" of chemical engineering classification has broken down for two main reasons:

(1) Most of the so called "unit processes" involve organic reactions where kinetics are the controlling factor. Despite wishful thinking on the part of some optimistic researchers, the status of applied reaction kinetics is still best described as embryonic. It is certainly not the basis on which commercial equipment is designed. Progressive scale-up and extensive pilot plant work are adequate evidence of the lack of knowledge in this area, although it is true that substantial progress is being made.

(2) These unit processes began to overlap so that the same basic unit operation (as defined earlier) was treated under two separate process headings. Stripping away this often wasteful parallelism, you come down to basic unit operations, or their divisions, as presented here.

What chemical engineers originally designated as "unit operations" were fairly small in number. Unfortunately, the tendency has been to hail as new "unit operations," each new innovation or modification of contacting or separating techniques involving permutations of solid, liquid and gas phases. Typical examples of so called "new unit operations" are: fluidized solids, ion exchange, leaching, dialysis, moving bed methods, flash techniques and spray equipment.

Consideration of reaction kinetics presents no problem in the classification now proposed. The additional factors of reaction kinetics are commonly encountered in many unit operations as defined here. In fact, unit operations quite often involve chemical as well as physical changes. Nowhere is this more obvious than in solids-gas operations. Such reactions as oxidation, reduction, halogenation, sulphatization, thermal decomposition, heterogeneous catalysis and even many drying operations involve chemical changes. In these cases, reaction kinetics may or may not be the vital determining factor in sizing equipment.

It would be ridiculous to attempt to draw a demarcation line in a drying operation, designating it as a "unit operation" as long as the water being removed was unbound moisture, and terming it a "unit process" when the water and other gases evolved is a result of chemical decomposition of the solid.

What This Means To You

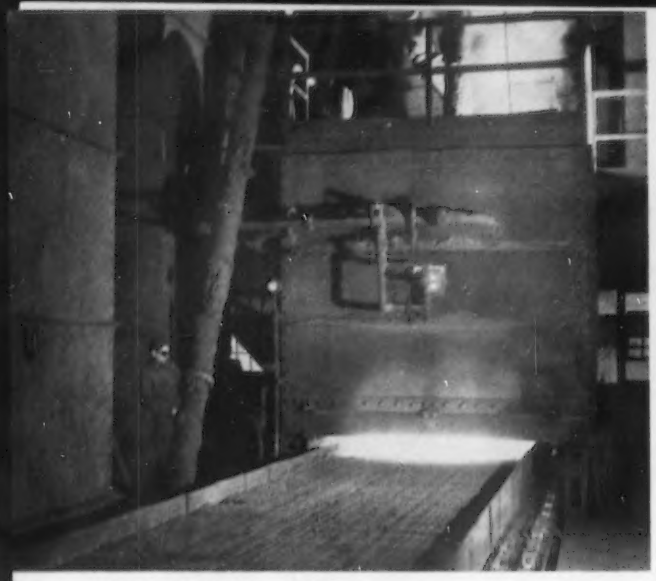
Perhaps the most useful concept is to consider unit operations as a series of building blocks by which you can characterize a sequence of processing operations. It pays off by making possible a completely objective analysis of existing or proposed plants. It permits the operator or the designer to examine each block, or even a series of blocks, with the question: What is the basic unit operation here? What methods are available to handle it? He is thus divorced from traditional equipment and the task of stretching and squeezing the metallurgical practice to fit the equipment.

Along the same lines, this classification system if practiced widely, should go a long way to eliminating the restrictive "process industry concept." Most engineers have intimate familiarity with at least one industry such as aluminum, zinc, fertilizer, petroleum, etc. They are well aware of growth, economics and changing technology in this field, but changes in other fields which might apply on their own jobs frequently escape them in the "process industry philosophy." It is not a very logical or useful means of classifying and using technology among the various fields which are partially related.

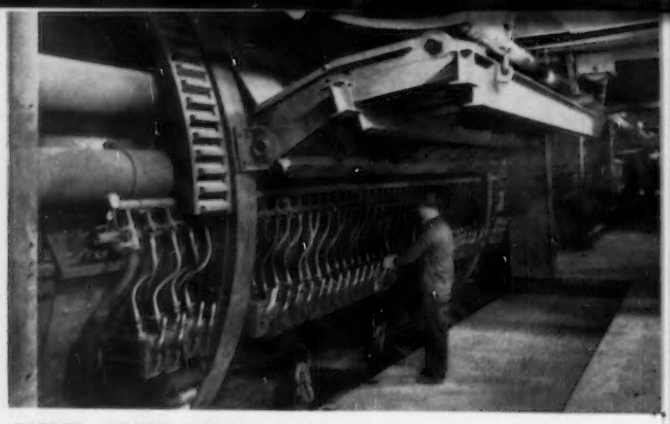
Descriptions and discussions in the literature of metallurgy along the lines of process industries are interesting but useless in working out basic problems of metallurgy. A unitized concept is obviously the solution, but a correct, logical and consistent unitized principle is necessary. Such an organization of technology is not available in any known metallurgical book or publication.

There is one more plus mark for this system. It helps the engineering school give the student a logical presentation of the knowledge that will be expected of him in his job instead of presenting him with a bewildering variety of "unit processes."

The concept presented here is a modified and simplified unit operation classification. It could well serve as a common denominator for all chemical and metallurgical operations and industries.



IRON ORE SINTERING . . .



COPPER CONVERTING . . .

These are some familiar Solids - Gas There may be better methods. If so

Solids-Gas Contacting—Close-Up

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WHETHER YOU'RE DESIGNING a new plant or modifying an existing one, gaining perspective is the first step, and nowhere is there a greater need for perspective than in solids-gas contacting operations—involving as they do many of the key processes of extractive metallurgy like calcining, roasting, smelting. To furnish perspective is the aim here.

Solids-gas contacting for our purposes is essentially the bringing of solid materials (ores, concentrates, chemicals) into contact with gas (air, chlorine, oxygen, etc.), long enough and under proper conditions to accomplish any of the purposes listed in the first column of the table at left.

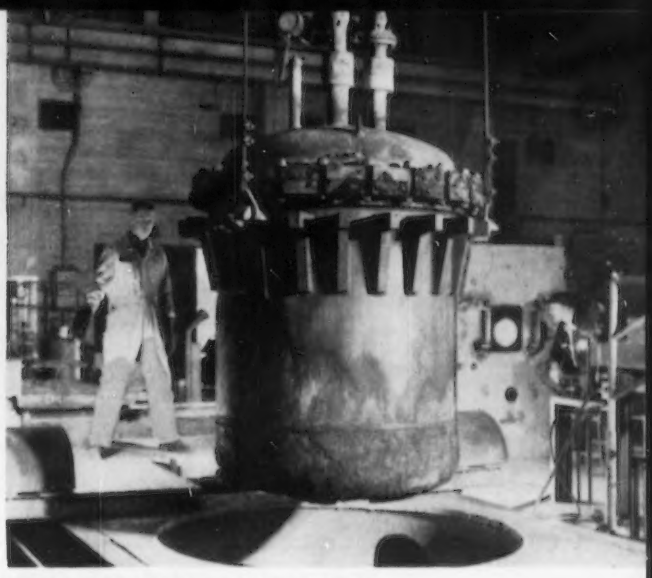
Innumerable schemes have been designed or proposed to accomplish various solids-gas contacting operations. Some of these were designed for very specific applications and do not appear to offer too much promise for other applications in the metallurgical and other industries. A few appear to be completely outmoded. On the other hand, quite a few appear to have a potential far beyond the applications for which they were originally designed. Among these are: moving-bed, spray, flash and fluidized-solids methods. However, it is quite clear that there is no single technique known that is a universally optimum method, or even generally suited, for all applications.

The tremendous range of operations encompassed in solids-gas contacting is so broad that undoubtedly there will

Solids-Gas Contacting Operations

This is the Operation	Here's What It Involves
Solid Composition Is Changed	
1. Drying	Removal of unbound liquid, generally water from solids, and the removal of vapors from gas streams by adsorption on solids.
2. Thermal Decomposition of Solids (Calcining fits here)	Often referred to as "calcining." This includes the expulsion of chemically combined water, volatile carbonaceous matter, and the gaseous products of decomposition of compounds such as metal carbonates, nitrates, sulphates, etc.
3. Chemical Conversion of Solids (Roasting comes under this)	Commonly referred to as "roasting." This includes: the removal of impurities by volatilization; the formation of chlorides, fluorides, bromides or iodides, sulphates, etc.: reduction of certain metallic oxides; conversion of non-magnetic compounds into magnetic materials; and alteration of physical properties of materials.
4. Sintering	Agglomeration of a finely divided solid material into a porous cellular cake.
5. Smelting	Charge consists of solids with product in liquid state.
6. Sublimation	Phenomena involving the conversion of solids to gas or gas to solid without presence of liquid.
Solid Composition Remains Unchanged	
1. Heterogeneous Catalysis	Interaction between gases of decomposition of vapor in presence of a solid catalyst.
2. Heat Transfer	Operations where chemical reactions or other phenomena are completely secondary to the transfer of heat, utilizing heat capacity of solids and/or gases.
3. Adsorption	Association between gases and solid surfaces may be either of a physical or chemical nature or both.
4. Chemical Regeneration of Solids	Alternate formation and decomposition of a chemical compound to achieve a desired separation. Heterogeneous Catalysis and Adsorption may be considered special cases of this since some sort of intermediate compound is often formed.

HORIZONTAL ZINC RETORTS . . .



TITANIUM SPONGE REDUCTION . . .

contacting operations.

you'll find them in this rundown of . . .

# of a Key Tool in Metallurgy

always be a need not only for many of the existing techniques and equipment but also for continued research and development aimed at new approaches. The vast majority of the supposedly new schemes which are proposed each year are obviously modifications of those discussed later in this article.

Surveys show that there is considerable inertia and reluctance on the part of the many industries to study objectively the relative merits of all alternate techniques. Consequently, in practically all industries the choice of equipment and apparatus for conducting operations such as drying, calcining, roasting, sintering and catalysis is often governed more by custom and personal familiarity of the designers than by truly comprehensive and thorough appraisals. Such objective considerations of alternate schemes can hardly be considered the responsibility of vendors of competitive equipment. It is hoped that this report may stimulate and perhaps provide a very preliminary basis for such systematic comparisons.

First let's examine the processes wherein solids-gas contacting is involved and then take a look at the equipment and techniques available. Emphasis will be placed on those segments which loom more importantly in the extractive metallurgy industry in today's world.

Analysis of Contacting Operations

ESSENTIALLY ALL the operations referred to (table left) consist of contacting of two or more phases and involve fluid mechanics, heat and/or mass transfer. As indicated previously, other operations such as crushing, solids classification, mixing, gas and solids separations, etc., may also be involved. The emphasis here will be placed on the prime reaction or process. Mixing and separation phenomena are, of course, important considerations but they will not be discussed here except insofar as they are particularly pertinent in establishing the basic points of similarity of these various operations.

When chemical kinetics is a factor, in addition to heat and mass transfer, the number of potentially important rate-controlling mechanisms increases tremendously. For instance, although diffusional phenomena are practically always involved when mass transfer occurs, the actual limiting factor in many instances is the rate of chemical reaction. Naturally, the relative importance of the pertinent factors varies considerably with the specific application.

The table (p 80) lists general factors that may be of importance in a given operation (not necessarily in any order of importance). An objective and comprehensive evaluation of such factors is necessary to permit proper selection of an optimum scheme, or the substitution of a new or improved technique for an existing process. The factors listed are intended to be typical and are not necessarily complete.

The following discussion of operations is divided, for convenience, into two categories: (1) Solid Composition is Changed; and (2) Solid Composition Remains Unchanged. This division is intended to underline the essential similarity of some of these operations and does not imply that either division consists exclusively of chemical or physical operations. The operations include such varied reactions as: (1) thermal decomposition of solids to form other solid products and gases; (2) reactions between solids and gases to form either a solid or gaseous product, or both; (3) reactions where the solid functions as a catalyst to influence the rate of reaction—it may form an intermediate compound but it is not one of the original reactants or final products; (4) use of contacting equipment for solids and gases as a heat transfer mechanism; and (5) removal of unbound moisture by simple vaporization.

Solid Composition Is Changed

Operations in which composition of the solid material is changed include:

1. Drying
2. Thermal decomposition
3. Chemical conversion to new compounds
4. Sintering
5. Smelting
6. Sublimation

1. Drying

There is a very large variety of equipment in commercial use for drying of solids. (Drying is defined here as the removal by thermal means of water or other liquids from solids, pastes or slurries.) This variation in equipment is largely due to differences

Information Needed in Planning a Solids-Gas Contacting Operation

I. Temperature Control.

1. What are the heat quantities involved?
2. Is the solid temperature sensitive?
3. Is the degree of temperature control critical?

II. Solid Composition is Changed.

1. Does the problem simply involve removal of unbound water?
2. Is it necessary to thermally decompose the material with evolution of water and other products of decomposition?
3. Is it desired to chemically react the solids with gases such as oxygen, chlorine, sulphurdioxide, hydrogen, etc? Is the process one of sintering with these products removed as an agglomerate?

III. Solid Composition Remains Unchanged.

1. Does the operation involve physical or chemical adsorption?
2. Is sublimation involved?
3. Does the solid serve merely as a heat transfer medium?
4. Does the solid function only as a filter?
5. Is the solid present only to catalyze the gas reaction?

IV. Product Properties.

1. Cost of product?
2. Product specifications and purities?
3. Is uniformity of product important?

V. Product Recovery.

1. Is dusting from the unit a problem because of health, safety or radiation hazards?
2. How easily may dust be recovered?
3. Is the gaseous effluent processed for recovery of products or better heat utilization?

VI. Feed Properties.

1. Is feed preparation necessary?
2. What are the surface area requirements of reacting solids?
3. Is there a tendency towards agglomeration?
4. Are the feed materials of a corrosive nature?

VII. General Considerations.

1. What capacities are involved?
2. Are countercurrent flow and uniform driving force important?
3. Are the operations flexible enough?
4. What is the total pressure required and what are the pressure drops involved?
5. Is there a need for sweep gases?
6. Is this a steady-state or batch operation?
7. Is the retention time important?

of physical and chemical properties, physical form, products specifications, thermal stability, corrosion characteristics of commercial materials, the scale of operations and the method of heat transfer.

One of the difficulties in trying to incorporate new developments into this field is the general tendency to treat drying operations, not as a science, but as a traditional art characteristic of a particular industry. In terms of variety of equipment used, tonnage of materials processed and money invested, drying is probably the most important of the operations discussed here.

Although practically all experimental drying studies have used water as the liquid, major decisions on engineering design are rarely based on fundamental considerations of the diffusion of liquid and vapor within the solid interstices, capillarity, shrinkage, pressure and gravity gradients. These mechansims are often the subject of conjecture in the evaluation of operating data. But actual plant design and operating procedure are almost always based on empirical data and experience, taking into consideration such factors as temperature sensitivity, feed and product specifications and gas conditions.

Assuming the technical feasibility of conducting a drying operation in various types of equipment, the logical choice should be based on a thorough comparison of investment and operating costs. Selection should always include some consideration of the steps preceding and following the drying, especially insofar as they affect the over-all cost.

Quite often the evaporation step preceding the final drying can be simplified by appropriate dryer selection. Substantial progress has been made in recent years in the use of new solids-gas contacting developments for drying operations and in the use of bench-scale data for the prediction of performance of large equipment.

In drying a solid, a number of processes occur simultaneously: (1) transfer of heat to raise the mass of solids to the vaporization temperature and heat necessary to evaporate the liquid; and (2) mass transfer as liquid and/or vapor within the solid and as vapor from the solid surface. The rate of the drying process is determined by the factors governing the rate of each of the component steps. An additional factor that may be involved is thermal decomposition, where the water removal is not from simple evaporation of unbound moisture but from release of chemically-bound water.

Heat transfer for industrial drying operations involve conduction, convection, and/or radiation.

Studies and theories of internal mechanisms of diffusion, capillary flow, shrinkage, etc. are of interest and importance in correlating data and helping to establish basic physical laws. However, although less fundamental, studies of external conditions are required for practical design and operation of commercial dryers. These include such factors as: temperature, humidity, air flow, state of division of the solid, contact between hot surfaces and wet solids, etc.

In extractive metallurgy, drying is often a necesary first step, particularly in the preparation of raw materials for chemical conversions. Such drying may be handled as a separate step in a process or it may be merely one portion of a sequence of operations in a given apparatus. In any event, operations following the drying step have an important bearing on the selection of conditions for drying.

Important factors in the preliminary selection of commercial dryers are:

(1) Properties of material being handled.

(2) Drying characteristics of the material.

(3) Flow of material to and from dryer.

(4) Product qualities.

(5) Recovery problems.

(6) Facilities available at site of proposed installation.

Among the methods for removing water vapor or other materials from gases are: absorption, adsorption, compression, and cooling. Adsorption, involving the use of solid adsorbents such as activated alumina and silica gel, are basically solids-gas contacting operations. The solid desiccants may be used in intermittent fashion or in a continuous circulating system, much as in the case of adsorption of noncondensable materials. Solid adsorbents function by removing water vapor by surface adsorption and capillary condensation. Solid absorbents such as anhydrous calcium sulphate, lime and magnesium perchlorate remove water vapor by chemical reaction.

2. Thermal Decomposition

Processes within this group include those commonly referred to as "calcination." They differ from drying in that the solid composition is altered, usually but not necessarily with the evolution of gases. The reactions are almost always endothermic. It should be noted that thermal decomposition reactions are often involved in processes designated as sintering and smelting.

Mechanisms involved in thermal decomposition reactions are similar to drying, particularly in regard to materials handling, heat transfer, separation of solids from the gases, etc. Accordingly, it is not surprising that much the same type equipment is used for these applications as in the drying of solids.

The most familiar example, and one of the most widely used, is the thermal decomposition of $CaCO_3$ to form CaO and CO_2. The term "calcination" originates from this application, although it is now often applied to all thermal decomposition processes. Other decomposition reactions are: calcining or "burning" of cement, lime, dolomite and magnesia products; calcining of bauxite, alumina, lithophone, and titanium pigments, regeneration of adsorbents; decomposition of ferrous sulphate; defluorination of phosphate rock; and various metallurgical operations for the decomposition of metal sulphates, sulphites, nitrates, nitrites, chlorides and other compounds.

An interesting and important illustration in the field of powder metallurgy is the decomposition of metal hydrides in order to obtain a product suited for compaction into massive metal.

Treatment of coal, peat, lignite and shale without contacting combustion gases involves thermal decomposition, with recovery of such products as ammonia, tar, light oil, naphthalene, anthracene, creosote oil, tar acids, road tars, etc. Numerous batch and continuous methods have been utilized for such operations, which are referred to as retorting or coking.

Dehydration or drying for the removal of bound water or water of crystallization is actually a case of thermal decomposition and, in some cases, such as dehydration of certain clays, temperatures far above the normal drying range are required to drive off this water.

A study of the huge number of decomposition reactions conducted in industry indicates a basic similarity among them as well as other solids-gas contacting operations such as drying and metallurgical roasting. Indeed, many variations of the batch and continuous equipment utilized for these latter operations have also been used for thermal decomposition.

Considerations of material handling, heat transfer scheme, capacity, distribution and contacting of solid and gas phases, separation of solids from gaseous effluents, etc. are remarkably similar for many of these solids-gas contacting processes.

Size or form of the solids involved in the thermal decomposition reactions are intimately related to the manner in which the operation is carried out, as well as the nature of subsequent treatments. Thus, following a thermal decomposition of metal carbonate or nitrate, a halogenation may be required which might best be conducted on material of a certain size and shape. This could well justify processing feed in this form, even in the preliminary drying and thermal decomposition steps.

Among the vital factors involved in the design of thermal decomposition units are: flow of gases; preparation, feeding, distribution, withdrawal and subsequent processing of solids; heat transfer; phase equilibria considerations; mass transfer of diffusion of gases; and reaction kinetics as a function of time, temperature and concentration of reactants in products.

While considerable progress has been made in the fundamental aspects of most of these and other factors, the operations involved in most commercial decomposition reactions are exceedingly complex. They must of necessity be designed for the most part on empirical bases, together with data from a number of large scale experimental studies.

3. Chemical Conversion to New Compounds

This category includes operations commonly referred to as "roasting" in the metallurgical industry, where solids are reacted with gases to form different chemical species. The product is generally removed as a solid phase, although conditions under which the reaction is conducted may result in the removal of one or more of the constituents or reaction products in the vapor phase. An illustration of this is the reaction of titanium dioxide, carbon and chlorine to form titanium tetrachloride which is removed overhead as a vapor and condensed.

Treated separately, although essentially similar, are other operations involving solids-gas reactions: sintering, with the product removed as an agglomerate; and smelting, with the product removed as a molten mass.

Utility and advantages of the unit concept, described on pp 75 to 77, is nowhere better illustrated than in this important division of solids-gas contacting operations. Operations involving the chemical reaction of solids and gases, in terms of numbers and sizes of installations, tonnage of product, financial investment and criticality in relation to other operations, represent some of the most vital phases of the metallurgical industry. The same is true of the chemical, petroleum, petrochemical, atomic energy, pulp and paper, and many other industries. The variety of conditions encountered by these industries, and the different approaches and philosophies prevalent among them, have resulted in an impressive and somewhat baffling array of commercial techniques and equipment.

Metallurgical roasting is generally

understood to comprise operations whereby an ore is heated under such conditions that the metal values of the ore are changed to some other form or rendered amenable to subsequent treatment. This product may be in the form of a metal oxide, sulphate, chloride or other compound.

If a metallic sulphide ore is heated under atmospheric air, the solid undergoes a series of changes involving decomposition and other reactions of the type discussed previously, as well as subsequent reactions of solids and gases to produce the desired product:

1. An initial drying phase with temperatures about 100 deg C to drive off mechanically held moisture.
2. As the temperature rises above 100 deg C, chemically-bound water and volatile carbonaceous matter are expelled, along with carbon dioxide from the decomposition or calcination of metal carbonates.
3. Metallic sulphides react with oxygen from the air to form oxides and sulphates of the metals as the temperature approaches a red heat.
4. Sintering or fusion of the unreacted sulphide may occur if the temperature is raised too rapidly without allowing the sulphide to oxidize.

Although there are innumerable others, the most familiar metallurgical roasting processes are: oxidizing, reducing, sulphatizing, and chloridizing. These terms are, of course, very broad designations for what are usually extremely complex and poorly understood chemical reactions. The importance of chemical, mechanical and thermal factors is obvious.

Solids-gas contacting operations are also quite common in the refining of various intermediate metal compounds. In the refining of uranium for the production of pure metal, uranium trioxide is converted to uranium dioxide by reduction with hydrogen; uranium dioxide is then reacted with hydrogen fluoride gas to produce uranium tetrafluoride. The reduction of this uranium tetrafluoride to metal with magnesium is, in effect, a solids-gas operation. The operation is conducted in a Kroll-type process with uranium tetrafluoride and magnesium loaded into a reduction "bomb" and heated to the ignition temperature. Under the conditions of the reduction, magnesium vapor reacts with the uranium tetrafluoride to produce uranium metal; molten uranium metal separates from the molten magnesium fluoride slag.

Thorium is produced in similar fashion by preparation and subsequent reduction of the intermediate thorium tetrafluoride.

Various modifications of the Kroll process for the preparation of intermediate chlorides of columbium, zirconium and titanium all involve solids-gas contacting. Many other examples could be cited. Whether the product is removed as a solid, liquid or gas depends upon the physical properties of the materials under the conditions of the reaction.

In preparation of titanium tetrachloride by static-bed chlorination of briquetted or sintered material, a mixture of titanium ore and carbon is chlorinated. Fluidized chlorinators involve the feeding of ground coke and rutile directly to the bed, thus eliminating the sintering or briquetting step. In either case, the solids-gas operation involves removal of the product, titanium tetrachloride, overhead to a cooling-condensing operation.

In the production of zirconium tetrachloride, the zirconium ore is first converted to the carbide with subsequent chlorination of the zirconium carbide to form zirconium tetrachloride which is removed overhead as a vapor. This vapor, due to its physical properties, is condensed or desublimed to form a solid product in the condenser.

Even in the batch reduction of the various metal oxides, chlorides and fluorides with such reductants as sodium, magnesium or calcium, the operation is usually a solids-gas contacting phenomenon rather than a solid-solid operation as is sometimes supposed. Reduction in batch "bombs" can proceed in most cases well below the boiling points of any of the constituents. The reaction generally proceeds not because of any perfect point to point contact of all the species involved in reaction but by reason of the appreciable vapor pressure of one or more of the materials present, thus producing an effective solids-gas contacting operation.

Since this discussion is restricted to solids-gas operations involved in chemical and metallurgical processing, no attempt will be made to discuss one of the most vital solids-gas operations in industry, namely, the combustion of solid fuels for the production of power. However, many of the materials handling, fluid mechanics, heat transfer and other factors are quite similar.

Practically all commercial solids-gas contacting equipment and techniques are important for some operations involving chemical conversions of solids. Many of the techniques—particularly several of the newer developments such as moving-bed, fluidized-solids, improved mechanical conveyors, flash and spray—should offer many advantages for varied metallurgical applications. Naturally, the relative advantages of these new methods must be compared with existing techniques on the basis of investment and operating costs, as well as technical feasibility. In view of the present methods of conducting many solids-gas contacting operations in both the metallurgical and chemical industries, there appears little doubt that there is a real potential for substantial economies by proper development and selection of new techniques.

4. Sintering

Sintering is generally defined as a process where finely divided solid material is agglomerated into a porous cellular cake by means of heat. The size of the resultant particles depends upon the extent of the fusion, which is a function of the residence time and temperature. Roasting may or may not be involved in sintering processes.

Size enlargement of particles by sintering or fusion is utilized in the processing of finely divided materials in equipment where high velocity gases would remove small particles from the reaction zone or where the rate of chemical reaction requires extended retention time. Among the materials treated by fusion or sintering processes are blast-furnace flue dust, ore concentrates, manganese dioxide ore, magnesia from sea water and brines, magnesite phosphate fines and dolomite.

Roasting operations may be conducted in such a way as to produce a final product in a sintered form. Sintering may also be conducted as a completely separate operation with or without added binders. The equipment used may be either batch or continuous. Batch or static methods may involve the use of grates or hearths with no accurate size or dimensional control on the finished product. Other batch techniques involve briquetting, where there is definite sizing of the final product. Continuous processes include the use of moving hearths and rotary kilns.

If air is passed through a mass of pulverized metal sulphide ore, one or more of the following may occur: (1) complete roasting, without sintering; (2) roasting and some degree of sintering; (3) sintering without roasting, as in the case of oxidized iron ores; (4) decomposition with the expulsion of water and carbon dioxide with some degree of sintering.

5. Smelting

In smelting operations the charge consists of solid materials, or ore concentrate, flux and perhaps fuel, with the products removed in the liquid state. At least a portion of the operation generally involves solids-gas contacting phenomena.

The only solid material removed from a smelting furnace is the dust and fume suspended in the effluent gases. In reduction smelting, the principal liquids produced are crude metal and slag. In matte smelting the liquid products are matte and slag. In each case two layers of immiscible liquids are produced which characterizes smelting as a distinct solids-gas contacting operation. In the smelting furnace one or more of the other solids-gas contacting operations may be taking place.

Reduction smelting is generally carried out in blast furnaces; matte smelting in reverberatories. The operations are so familiar to those in the metallurgical field that they require no further discussion here.

6. Sublimation

Sublimation consists of direct formation of a vapor from a solid phase without passing through the liquid state. The term is also applied to the reverse process, or condensing directly from a vapor to the solid state. Whether a material will sublime, or whether it will melt and then vaporize, depends on the location of the triple point, or the point of intersection of the sublimation, vaporization and melting-point curves. Vaporization of a solid without prior melting can be carried out only at pressures below that of the triple point.

Sublimation is not very widely used, although there are some important processes that incorporate this operation. Sublimation can be of value in: purification; introduction of components into a gas-phase reaction; and removal of products from a gas-phase reaction by desublimation. Sublimation is comparable to distillation as a separation operation. Among the materials of commercial importance which involve sublimation, vaporization or condensation phenomena are: calcium, iodine, camphor, magnesium, naphthalene, sulphur, zirconium tetrachloride, mercury and uranium hexafluoride.

Two general methods of sublimation are used:

(1) simple sublimation — generally requiring the use of vacuum in order to reduce total pressure.

(2) carrier sublimation—when the gas phase is composed of the material being sublimed plus other materials introduced either deliberately or unavoidably.

In simple sublimation the pressures in the system are the vapor pressures of the subliming materials at the temperatures of operation. Condensing surfaces must be kept clean and residual gases continually pumped out to maintain high production rates. Molecular distillation is a special case.

In carrier sublimation the carrier gas must be inert toward the products and have a vapor pressure in excess of the sublimate. The carrier gas may be condensed with the sublimate provided it does not contaminate the product. The major problem in the design of equipment for either type of sublimation is the transfer of heat to and from the solids.

Practically all sublimation equipment is custom-designed for specific applications. Vaporizers include numerous types of pots, kettles, and retorts. Since heat transfer to solids is a limiting factor, maximum agitation and close-clearance agitators are essential when jacketed pots are used. Batch-type units include tray and pan designs, similar to those used for vacuum drying. For continuous operation, rotary and multiple hearth type units have been designed. Special precautions are necessary in all cases to prevent preliminary cooling of vapors, with subsequent plugging.

The principles of design for vaporizers are in many ways similar to those for commercial dryers and distillation equipment.

Among the condensing systems that have been designed are: large tubes, water- or air-cooled, with continuous mechanical scrapers; shell- and tube-condensers in parallel operating on alternate condensing and cleaning cycles; large chambers using radiation cooling, liquid-spray cooling, or conduction-convection cooling; pervious cloth walls; metal screen walls and chain walls, all with mechanical shaking; and recycled, cooled inert gas, from which the desublimed products are settled out in large chambers or filtered in bag filters.

Solid Composition Remains Unchanged

The operations discussed in this section are:

1. Heterogeneous catalysis
2. Heat transfer
3. Regeneration of solids
4. Adsorption

Only brief mention is made of these important solids-gas contacting operations since their chief uses lie outside of extractive metallurgy.

1. Heterogeneous Catalysis

Chemical reactions may be classified as homogeneous, where only one phase is involved, or heterogeneous, where more than one phase takes part in the reaction.

A catalyst is defined as a substance which influences the rate of a reaction by participating in intermediate steps to facilitate the over-all course of the reaction. However, the catalyst is not one of the original reactants or final products.

Solids-gas contacting methods apply where solid catalysts are used to increase the rates of reactions where reactants and products are gases.

2. Heat Transfer

Some of the most interesting developments in the use of solids-gas contacting methods involve the moving-bed and fluidized solids techniques to store and transfer heat from one process vessel to another. They take advantage of the high heat capacity characteristics of solids.

Pebble heaters have been used for heating air, hydrogen, methane, steam, etc., in various industrial operations. They have also been used for the recovery of heat from hot gases discharged from other processes.

An extremely interesting illustration of a solids-gas contacting operation involving no change in composition of the solid is the use of gases to cool nuclear reactors.

3. Regeneration of Solids

Involved here are such cases as the removal of water from gaseous streams with the formation of solid hydrates which are subsequently regenerated. Similar operations are involved in the removal of sulphides, carbon dioxide and obnoxious gases from gaseous effluents. In each case a solid may be used to combine chemically with the constituent to be removed with subsequent removal by thermal decomposition.

4. Adsorption

There has been increasing interest in the removal of relatively small amounts of materials from gases by adsorption on solids.

A number of solids-gas contacting methods should be well suited for adsorption.

What Equipment, Methods Can Be Used For Solids-Gas Contacting?

OPERATION / EQUIPMENT, METHODS →	Continuous[1]								Batch[2]		
	Rotary kiln	Mechanical conveyors	Moving bed	Fluidized bed	Spray	Smelters	Multiple hearth furnaces	Fixed bed	Trays and compartments	Pot or autoclave	Special designs
Solids Composition Changed											
Drying	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Thermal decomposition	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Chemical conversion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sintering	✓	✓	✓	✓					✓		✓
Smelting[3]						✓					✓
Sublimation	✓	✓	✓	✓				✓	✓	✓	✓
Solids Composition Unchanged											
Heterogeneous catalysis		✓	✓	✓				✓			
Heat transfer[4]		✓	✓	✓	✓			✓			
Regeneration of solids			✓	✓				✓			
Adsorption			✓	✓				✓			

[1] Continuous units are those having a steady state flow of gas and/or solids.
[2] Batch units have no flow of gas or solids during operation and composition of both phases is constantly changing.
[3] Smelting is regarded as a special case in which products are removed as liquids. Obviously both thermal decomposition and chemical conversion may be taking place during a smelting operation. See text.
[4] Heat transfer referred to here is the basic purpose of the solids-gas contacting operation. Naturally, heat transfer is involved in all solids-gas contacting operations.

Commercial Equipment for Solids-Gas Contacting

THIS SECTION PRESENTS a brief review of commercial equipment available for bringing a gas and a solid into contact so that drying, catalysis, chemical reaction, heat transfer or other operations may occur. The equipment used commercially has been arbitrarily divided into two main groups: continuous and batch. Under continuous equipment are discussed: rotary; moving-bed; fluidized-solids; multiple hearth; flash and spray; mechanical conveyors; smelters and special designs. Batch equipment has been divided into: trays or compartments; pots; retorts; induction heated units; and fixed-bed units. The designations are in many cases arbitrary and unavoidably overlap to some extent.

A brief description is given of the more important types of equipment, along with advantages, limitations and applications. Important factors are listed (p 80) which should be considered in the selection of equipment for solids-gas contacting operations. Although they may be at variance with present practice—which is often dictated more by custom than by reason—suggestions are included for the types of equipment that might be considered for various operations.

Since there are many intangibles involved in any operation, it is not possible to present concise and comprehensive criteria for the best way to conduct a given operation. However, an attempt has been made to list the more important factors which should be considered in the selection and design of solids-gas contactors.

Continuous Process Equipment

Rotary Kilns

Rotary kilns or furnaces are among the most important types of process furnaces used in industry. The feed requires little or no size preparation and generally includes a broad range of particle sizes from dust up to large lumps. They are used for the burning of lime, cement, dolomite and magnesia products. They are also used for dehydrating, roasting and sintering materials such as alumina, bauxite, phosphate and chromite.

Rotary equipment may be grouped into three main categories: roasters or kilns, coolers and dryers.

There are three main zones in a rotary kiln: (1) a drying zone, where moisture is driven off; (2) a heating zone which comprises most of the kiln length; and (3) the heating or burning zone where the charge is decomposed, oxidized, reduced, etc. Some kilns also contain a recuperator section where the charge may be either further heated or cooled.

The uses of rotary kilns include calcining of cement, lime, bauxite, magnesite, dolomite, gypsum, clay, vermiculite and innumerable others. They are also used for roasting and chloridizing operations in the processing of gold, silver, titanium and potassium salts. Other uses include volatilizing of mercury and zinc and the sintering of iron ore and phosphate rock.

Rotary coolers of various designs are used for the prodution of cement, lime, alumina, magnesia and various chemicals.

Rotary dryers are similar to kilns but the dryer is generally much smaller. Since dryers involve much lower temperatures, no refractory lining is necessary. As a rule both dryers and rotary coolers are set at greater slopes and rotate faster than kilns. Dryers and coolers are generally equipped with ledges or flights on the

interior walls, designed to pick up material and spill it through the flow of gas. Dryer applications include the processing of clay, various salts, dolomite, limestone, ilmenite, gypsum, ammonium sulphate, manganese and phosphates. Dryers are common ahead of electrostatic separators and high-tension magnets.

The direct single-shell rotary dryer consists of an inclined rotating cylinder in which wet material showers through the gas due to lifting flights attached to the cylinder wall. In the indirect-direct rotary dryer, the material receives heat from the hot gases by conduction through the dryer shell and by direct contact.

In the rotary kiln the material travels as a solid bed on the bottom of the rotating cylinder. Rotary kilns are used extensively for roasting, calcining and sintering. Drying is usually secondary to the other desired reactions.

To accomplish the drying or chemical reaction, hot gases flow either concurrent with or countercurrent to the flow of solids. Although counterflow provides more efficient heat transfer, concurrent flow allows the drying of heat-sensitive materials at higher temperatures. Hot gases are forced through the equipment by a blower and/or exhauster.

The hot exhaust gases from the rotary equipment may contain dust particles which can be processed in wet or dry collectors to avoid contamination of the atmosphere or to improve product recovery.

Rotary equipment is normally used for relatively free-flowing granular materials. Pastes and sludges are handled by special means such as premixing the wet feed with a portion of recirculated dry product, use of special flights, vibrators, slurry evaporating chains, etc.

The outstanding advantage of rotary equipment is its adaptability to handle a large variety of mineral, chemical and ceramic products, good quality and uniformity of product, flexibility of throughput and operating conditions.

Fine dusty materials usually cannot be handled in rotary equipment, nor can solids which must meet demanding specifications of size and shape. Advances in mechanical design, provisions for recirculation of solids, and improvements in thermal efficiency have resulted in a number of new uses for rotary equipment.

Rotary units are particularly well adapted for continuous operations for either very small or very large capacities. Furthermore, any given size unit can be made flexible for a wide range of varying capacity, temperature and retention time.

Disadvantages include the relatively inefficient contacting of solids and gases, low heat transfer coefficients when heat is transmitted through the walls of the rotary equipment, and the relatively large size of the equipment per unit of capacity. Considerable competition for rotary equipment has and will be provided by some of the newer developments such as the moving-bed, fluidized-bed, conveying, flash and spray techniques.

Mechanical Conveyors

Conveying equipment is characterized by the fact that the solid material is agitated or moved while being contacted with a gas. It includes: screw and vibratory conveyors, contacting towers, gas lifts and belts, moving trays and screens, drums, etc. The conveying operation is, of course, incidental to the prime functions of drying, chemical reaction, sintering, etc.

The screw conveyor is used as a solids-gas contactor through which solid is conveyed as it contacts gas flowing in the same or opposite direction. And, totally enclosed vibrating conveyors are also used with screens or solid decks over which the solid moves, with the gas flowing through or across the solids.

In the tower contactor the solid cascades down a baffled tower against a rising gas stream. The solid material is simultaneously contacted and conveyed by means of a gas stream in the gas lift.

Each of these equipment types has inherent advantages and limitations. Most conveyors are characterized by flexibility of operation and low space requirements. The screw conveyor should not be used where product degradation must be avoided, nor the vibratory equipment for materials having long contact times. Due to the short contact time—which may not be advantageous under certain circumstances—temperature-sensitive materials may be contacted in the gas lift. Very abrasive, brittle or sticky substances cannot be handled in a gas lift for obvious reasons.

All classes of conveying equipment mentioned require a relatively free-flowing granular feed. An exception is the screw conveyor. It may handle some pastes and sludges.

It is probable that conveyors will continue to be used on a broad scale in both the chemical and metallurgical industries. It is likely that major inroads by such new processes as fluidized-bed and moving-bed methods will involve the replacement of many of the above operations in our plans for tomorrow.

Tunnel equipment may be considered a variation of mechanical conveyors, although tunnel kilns and furnaces are often treated as a separate category.

Material to be treated in tunnel equipment is placed on trucks which are moved semi-continuously through an enclosed tunnel in contact with hot gases. Gas flow may be parallel or countercurrent to the material flow for efficient operation.

The two types of gas flow may be combined in one piece of equipment. In the center-exhaust tunnel dryer, the feed end of the tunnel operates with parallel gas flow and the discharge end with countercurrent flow. The exhaust gases leave at the point of changeover.

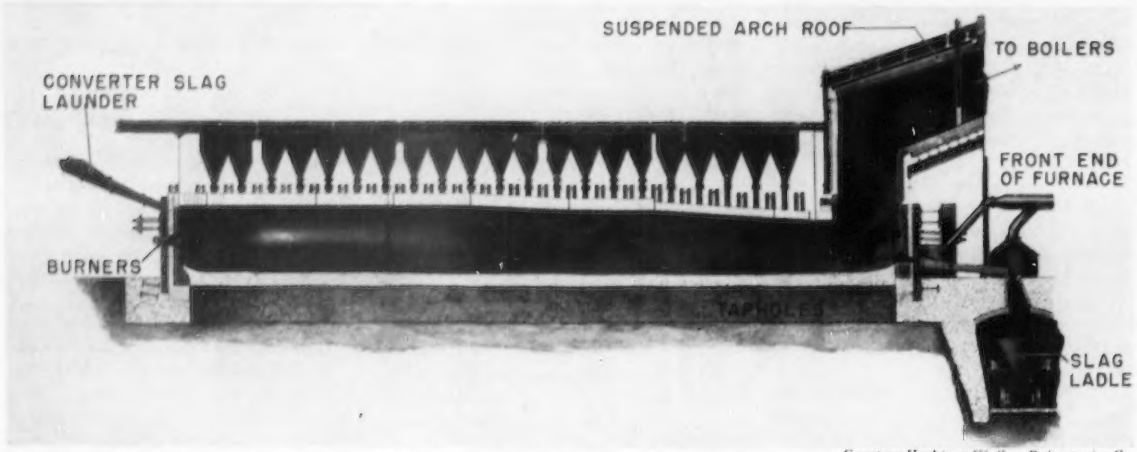
In this instance the operation is adiabatic for a single pass through the tunnel. The tunnel dryer may also be operated at a constant temperature with cross-flow of the gas through each truck followed by preheating between trucks. In this way the temperature and humidity of the gas are controlled effectively. This allows temperature- or humidity-sensitive matrials to be dried.

Tunnel dryers are particularly suited to drying materials that tend to warp and check, such as leather, wallboard and veneer. They are also used for drying large solids and special shapes.

In summary, mechanical conveyors are used for a variety of important industrial operations: drying, decomposition, roasting and sintering. While the designs include a wide variety of techniques for feeding and discharge of the solids, the prime consideration is the mechanical conveying system through the dryer or kiln.

This category includes continuous dryers, whether heat is transferred directly or indirectly. The direct continuous types include: continuous metal belts, vibrating trays, vertical turbo-dryers, continuous sheeting dryers, through-circulation units with solids on continuous conveying screens, cylinder dryers for continuous sheets of paper, cellophane, etc., drum dryers, screw conveyors and various special types such as continuous fabric belt units. In view of the vast variety of materials handled in mechanical conveyors, no attempt will be made to list specific applications.

Sintering equipment can be considered a special case of mechanical conveying solids-gas contactors where moving trays, belts or screens are utilized. Sintering may also be in-



Courtesy Harbison-Walker Refractories Co.

SMELTERS like this reverberatory furnace may have all phases of matter, solid, liquid and gas, present during operations but the basic problem is essentially one of solids-gas contacting. The reverberatory is primarily a melting furnace.

volved as one phase of a series of successive processing steps which also include drying, decomposition and chemical conversions.

Moving-Bed Equipment

Shaft or vertical kilns involving moving-bed solids-gas contacting have been used for many years in the metallurgical industry for the production of pig iron, copper and lead.

The moving-bed principle is widely employed in industry, as indicated by its use in blast furnaces, shaft kilns and petroleum processing. A moving bed can be defined as a body of solids in which the particles—consisting of pellets, beads or briquettes — flow downward by gravity at substantially their normal, settled, bulk density through a vessel in contact with gases. Gas flow may be parallel or countercurrent to the solids, providing the rate of gas flow upward is not high enough to cause the bed to boil as in fluidization.

The oldest and probably the most important use of a moving-bed or shaft furnace is the blast furnace used for the production of pig iron. In terms of investment and capacity, these represent the most important application of the moving-bed method in a field other than petroleum. Actually a blast furnace functions as a continuous, vertical smelter, that may roast, reduce and melt, all in one unit. To this blast furnace, in the production of pig iron, are charged iron ore, coke and limestone. The coke functions both as fuel and reducing agent and must support the entire charge, maintaining it as a loose aggregate to permit gases to pass readily. A blast furnace of similar construction is used for the manufacture of phosphorus and phosphoric acid by the reaction of phosphate rock, coke and sand. The blast furnace gas in this case contains the phosphorus as a vapor.

The main limitation of blast furnaces has been in the handling of finely divided material for which reverberatory furnaces are superior. However, the blast furnace has a much higher thermal efficiency than the reverberatory and uses a true countercurrent principle. Furthermore the reverberatory is primarily a melting furnace. Recent progress in the pelletizing of taconite fines should facilitate the processing of this material in a moving-bed unit.

Shaft kilns have been used extensively for the calcination of limestone and to some extent the manufacture of cement. There are also numerous designs of shaft furnaces used for gas producers, water gas generators and retorts for the thermal decomposition of coals, shale, lignite, etc. for the recovery of volatile products.

One of the major advantages of the moving-bed technique is that it lends itself well to the true intimate countercurrent contacting of solids and gases. This provides more efficient heat transfer and a more uniform drying force in the case of mass transfer. The moving-bed contacting method also permits the use of the solid as a heat transfer medium.

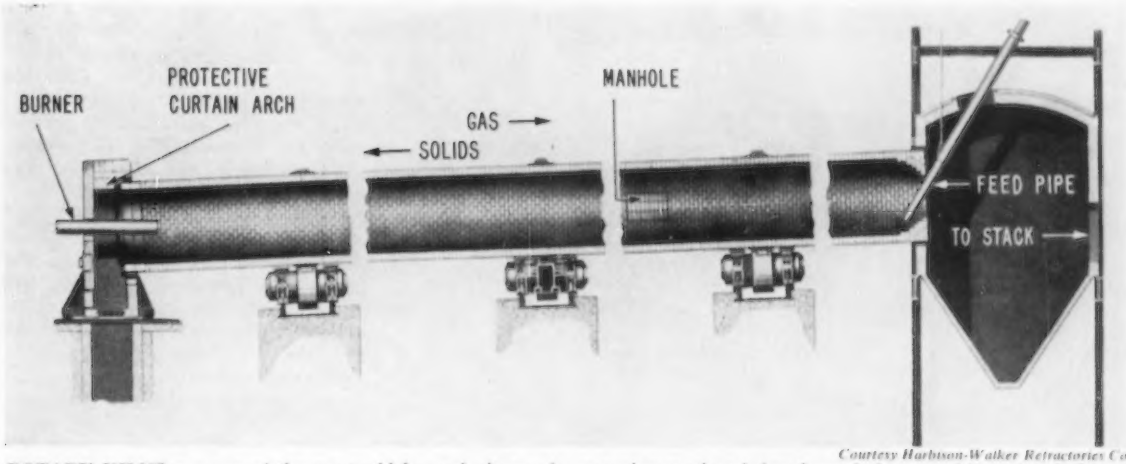
The efficiency of solids-gas contacting is high due to uniform distribution of the gas throughout the bed of solids. Feed preparation is an important factor and is largely determined by the physical requirements of the solids. Dust recovery is minimized in this type of unit since a packed bed actually functions as a fairly efficient dust-recovery medium.

The moving-bed technique appears to have a real potential for a wide variety of operations, both with the solid composition changed and unchanged. The operations which have been suggested, studied or applied include literally all of the types cited above—drying, reduction, calcination, oxidation, halogenation, sulphatization, volatilization, heat transfer, catalysis, etc. One of the inherent problems in such a technique is the necessity for proper formation of feed in the form of discrete particles, pellets or briquettes. The potential advantages include flexibility of solid in gas flow rates and capacities, variable retention times, ease of start-up and shut-down, simple provision for concurrent or countercurrent flow permitting large numbers of stages, minimized problems of dust entrainment, suitable temperature control, etc.

In view of the various refinements that have been incorporated by the metallurgical, chemical and petroleum industries, the modern moving-bed technique has one of the best growth potentials of any of the solids-gas contacting equipment discussed. For this reason, its application to the chemical and metallurgical industries will appear in forthcoming issue of *E&MJ*.

Fluidized-Bed Equipment

A fluidized-bed can be defined as one in which a mass of finely divided



Courtesy Harbison-Walker Refractories Co.

ROTARY KILNS are one of the most widely used pieces of equipment in pyrometallurgy. Biggest use is for drying but they are also employed for thermal decomposition, chemical conversion, sintering and sublimation.

solids, ranging from 10 to 400 mesh, is maintained in a turbulent dense state by being dispersed in an upward-moving gas stream. The top of the dense phase bed has a well defined level, resembling a boiling liquid. If the gas velocity is further increased, entrainment increases to a point where the bed level disappears and a single dilute phase suspension is present through the entire vessel, as in pneumatic conveying.

The fluidized-solids technique was developed by the petroleum industry for the catalytic cracking of petroleum feed stocks to provide high yields of gasoline. The technique appears to have special application for many solids-gas contacting processes, particularly those requiring good control of temperature. The operations may include practically all of those cited above where the solid is changed or unchanged, where the reactions are catalytic or non-catalytic, where the solids participate as a direct reactant or merely serve as a heat carrier.

Among the applications that have been studied extensively are: calcination of limestone, dolomite, metal hydrates, magnesite, etc.; drying operations; adsorption; chlorination, including volatilization of metallic chlorides; sulphatization, such as the conversion of copper oxide to copper sulphate; various decomposition reactions; oxidation and reduction reactions in metallurgical operations; and many others.

Obviously, in a single boiling-bed operation there will be particles which short-circuit the bed and leave rapidly, even though they have been freshly added. On the other hand, some particles will undergo extremely long residence times in the bed. In order to counteract this problem, attempts have been made to design a countercurrent series of beds. The preparation of solid feed in the proper size range is also a very important consideration.

In many operations an important factor is the efficient removal of adsorbed or entrained gases or vapors from the solid product. The most important problem, however, is the removal of solids from the effluent gases. This has been one of the most serious if not the most critical problem in the application of the fluidized-solids technique to many metallurgical operations. Cyclone separators are generally used in commercial installations, frequently followed by Cottrell precipitators. Liquid plate - column scrubbers have been used in place of cyclones in some instances.

There are some important advantages: good degree of temperature control and uniformity of temperature throughout the fluid bed, high heat transfer and reaction rates, relatively simple solids removal and makeup, and uniform solid phase composition.

Inherent disadvantages: not adaptable to countercurrent operation; entrainment of solids in gas stream may be prohibitive; the extent of secondary reactions is increased by longitudinal mixing in the bed.

Spray Equipment

In spray equipment, the material to be contacted is fed into a hot gas stream as a highly dispersed liquid slurry or solution. A typical spray unit consists of: a contacting chamber, a source of hot gases, a means for atomizing the liquid feed and a means for separating the finely divided product from the exhaust gases. Flash units operate on similar principle with solids rather than liquid dispersed in the gas stream.

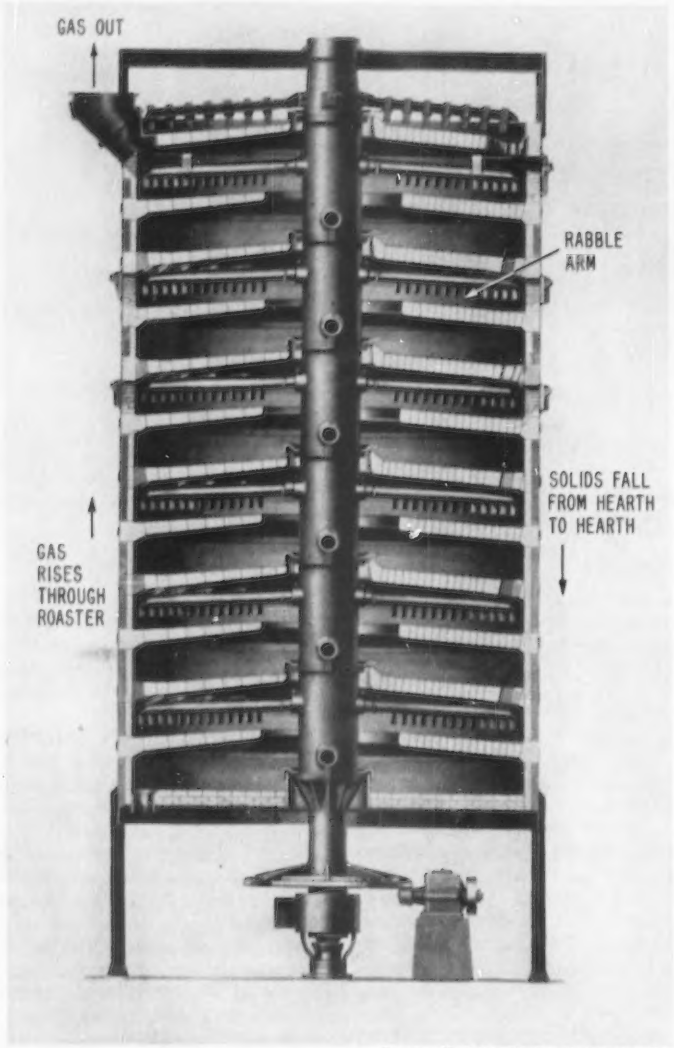
Spray equipment may operate with countercurrent or parallel gas flow. The hot gases may be used in a once-through operation, or recirculated through the unit in a closed system. Inert gas, superheated steam or other vapors can be used as contacting media where a special atmosphere is desired.

Spray drying is one of the few commercial-scale operations suitable for the drying of liquids and slurries. It is also applicable to the drying of many heat-sensitive materials. An additional advantage is the ease of control and variation of product properties.

Among the inherent disadvantages are the relatively low product bulk densities. The equipment, particularly the atomizers, is relatively inflexible and larger evaporative loads are required of spray dryers for a given throughput because of dilution effect.

The spray technique has been adopted for many new and interesting applications over the past few years. There is room for even wider application in chemical and metallurgical fields, provided appropriate designs for atomization, dust recovery and gas recirculation are incorporated for each specific use.

The principle advantages of spray drying include: Desired product properties and quality values may be efficiently controlled and varied; choice of construction material is



Courtesy Harbison-Walker Refractories Co.

MULTIPLE HEARTH FURNACE offers wide range of capacities, better temperature control and flexibility than kilns. Main uses are drying and calcining.

often simplified because the material does not contact solid surfaces until it has become dry; due to short contact times it is particularly applicable to the drying of heat-sensitive materials. The use of the spray technique often simplifies other operations such as filtration of the feed or pre-forming of the solid feed as well as sometimes eliminating the need for size reduction of the dried product.

Among the inherent disadvantages of spray drying are: low product bulk densities where a high density product may be required; relative inflexibility of operation; for a given capacity, larger evaporative loads generally are required than for other types of dryers; and the problems of product recovery and dust collection may increase the cost of drying by an appreciable amount especially where bag filters or wet collectors are required.

Spray drying involves the formation by atomization of a highly dispersed liquid state in a high temperature gas zone, followed by rapid evaporation and drying of the droplets. Three important phases are involved: atomization; drying of liquid drops; and spray-gas mixing. A fourth might be added, the removal and collection of dry product.

The determination of the spray-drying characteristics of a given material is almost entirely empirical. It is advisable, wherever possible, to obtain data from pilot scale operation.

While the above discussion emphasizes drying operations by the spray technique, all of the statements are equally applicable to chemical decomposition and other reactions, many of which have been studied or applied on a commercial scale. The spray technique has been used for production of dry milk, soaps and detergents, pharmaceuticals, fine chemicals, organic and inorganic chemicals, the processing of materials in the pulp and paper industry, the production of such chemicals as manganese sulphate, aluminum sulphate, sodium sulphide and zinc sulphate.

Many variations of the spray method have been suggested and patented. However, there appear to be two main groups: (1) drying, decomposition or chemical reactions of solids with a recirculating gas stream. The recirculating gas stream may be either heated or cooled depending upon the operation requirements. (2) The same general types of processes with a once-through type operation. Gases are not recirculated and heat is transmitted by radiation techniques from the walls of the reactor.

Flash drying involves the instantaneous removal of moisture from materials by the application of heat in a turbulent stream of hot air. Similarly, flash roasting includes operations such as decomposition of metal nitrates and carbonates or the oxidation, reduction or other reactions of various materials. Although they are sometimes erroneously considered a special type of fluidized solid reactor, they are better classified as a variation of the spray technique.

Flash roasters are particularly well suited for very fine particles such as the sulphides of iron, zinc, copper and nickel which react with oxygen in the air with the generation of heat. Sulphur dioxide and metal oxide are formed, with the sulphur dioxide recovered for processing into sulphuric acid. Metal oxide is recovered for the production of metal. The operation is in many ways similar to one or more of the variations of spray, roasting or drying except that the feed involves carrying the fine charge particles with a stream of gas into the combustion or reaction chamber. The problem of removal of fine solids from the effluent gas streams is just as important and serious as in the case of spray and fluidized-solids equipment.

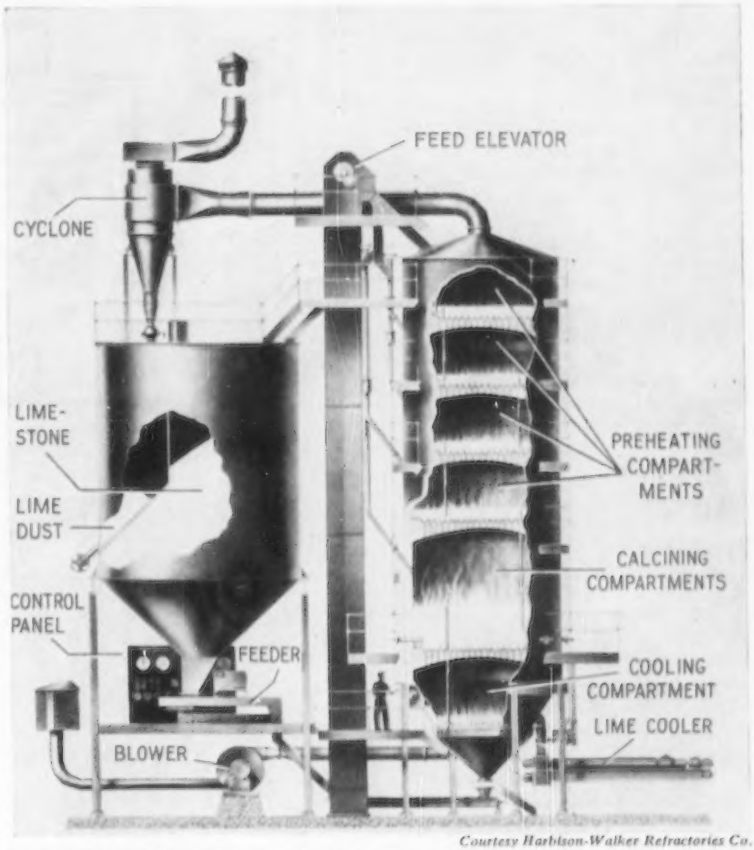
Additional applications of the flash technique are the retorting or decomposition of coals and lignites in an inert atmosphere of recycled process gases, with the recovery of desired

volatile constituents. The technique is at least technically feasible for many other compounds such as metal nitrates and sulphites, which can be thermally decomposed, with the recovery of gases such as nitrogen oxides or sulphur dioxide.

Flash roasting involves the exposure of a very large surface area of solids to the action of roasting gases, by injecting a stream of finely divided solids directly into the combustion zone. This permits rapid and efficient removal of the gaseous products and increases the speed of reaction to such an extent that the time of roasting may be of the order of seconds. This technique is obviously directly related to such operations as pulverized fuel firing, spray and pneumatic drying and fluidization methods.

Flash units have been built for the roasting of iron pyrites for sulphur dioxide generation. Preparation of raw materials for these and similar applications may require operations of drying, crushing, grinding and air classification. The raw material is fed into the reaction chamber by means of a carrier gas. A tangential motion is often imparted to this gas, permitting the larger particles to settle out in the main chamber. The effluent gas is then processed by one of several means for separation of solids.

Flash units have also been built for the removal of water crystallization from copper sulphate. Units incorporating the flash technique have been built for simultaneously drying, pulverizing and classifying clays.



Courtesy Harbison-Walker Refractories Co.

FLUIDIZED BED may be described as a mass of finely divided solids maintained in a turbulent, dense state by being dispersed in an upward-moving gas stream.

Smelters

As mentioned previously, smelting may be conducted in either a blast or a reverberatory furnace. The smelting of iron ore to produce pig iron in a blast furnace involves two general phases: (1) the reduction of oxides of iron to the metallic state—which involves a series of complex solids-gas chemical reactions; and (2) fusion of the entire mass to form molten metal and liquid slag.

The fusion operation in a blast furnace is basically a melting operation. The roasting and reduction operations, however, involve chemical reaction between solid constituents and the rising column of gas in the furnace. The charge must therefore be sufficiently porous to permit a uniform flow of gas through the interstices of the solid bed. It is for this reason that excessive quantities of fine material would result either in entrainment of the particles in the gas current, or packing of the bed, or both.

Blast furnaces have also been used for other metallurgical applications, although they are not as important as the processing of iron ore. The outstanding characteristic of the modern blast furnace is still its tremendous capacity. New techniques, in order to be competitive with the blast furnace, would have to demonstrate comparable capacity and economy. However, there are a number of possibilities for improving the efficiency of blast furnaces, utilizing technology and experience from other industries as well as the metallurgical field. These include: utilizing higher blast pressures; increasing stock-line diameters, thus decreasing gas velocity and minimizing excess flue-dust; enriching the blast with oxygen; removing moisture from blast and utilizing low-sulphur coke; increasing blast temperatures; and providing more uniform feed by appropriate screening, and agglomeration techniques.

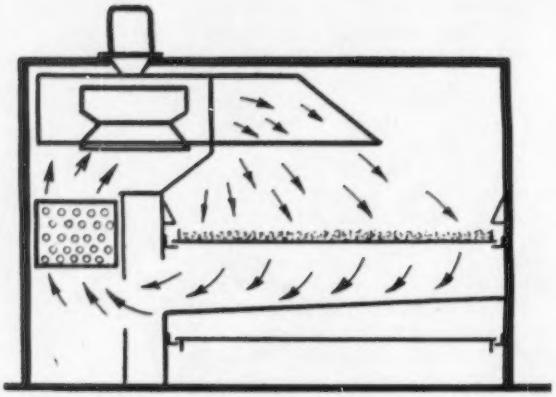
Smelting actions in reverberatory matting furnaces are essentially simple melting operations.

Multiple-Hearth Furnaces

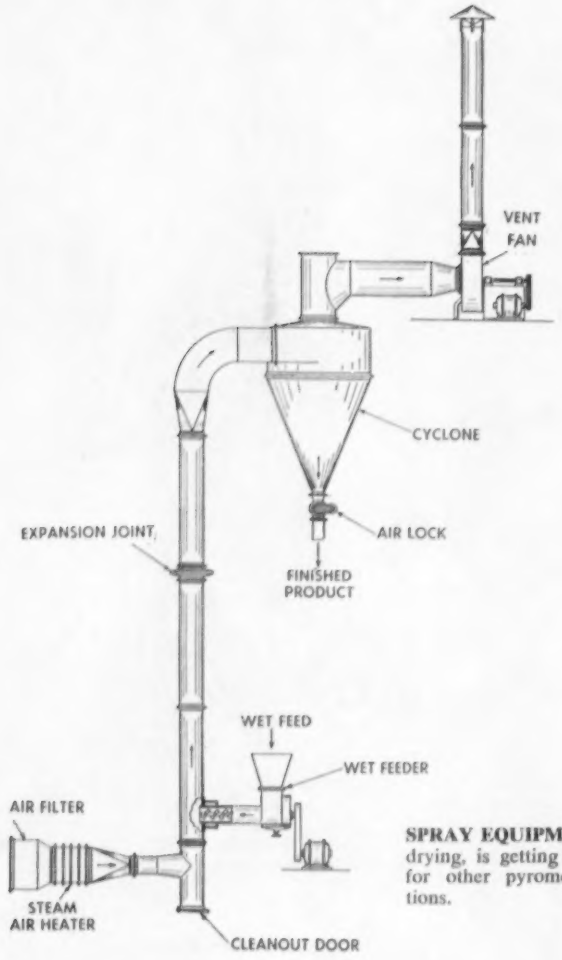
This type of roaster is in the shape of a vertical cylinder containing a number of superimposed horizontal hearths. Gas enters from the bottom and contacts ore or concentrate which is fed at the top and drops from hearth to hearth in succession until discharged at the bottom.

Multiple hearth furnaces are available in a wide range of capacities and provide improved temperature control and operating flexibility as compared to rotary kilns.

Capacities range from 200 lb per day to over 500 tpd per unit. Hearth diameters range from 18 in. inside to 20 ft outside, with from one to sixteen hearths. Applications of these furnaces include drying and calcining of limestone fines, kaolin, gypsum, soda products, vermiculite, bauxite, fullers earth and diatomaceous earth; roasting of ores and concentrates for the manufacture of acids, and the production of metals such as nickel, cobalt, tungsten, mercury, zinc, copper and molybdenum; regeneration of



MECHANICAL CONVEYORS of all kinds are used in solids-gas contacting for flexibility, low space requirements.



SPRAY EQUIPMENT widely used in drying, is getting more consideration for other pyrometallurgical applications.

carbon, filter media, catalysts, various chemicals and bone char; drying of sludges, ores, concentrates, coal, sands and chemicals; and the carbonization of hydrocarbons, coal, lignite, etc.

Solids are moved across each hearth and into drop-holes by rabble arms attached to a central rotating shaft. Usually there are two or four rabble arms for each hearth. The retention time of a particle of ore per hearth is controlled by a number of rabbles, angularity of the adjustable rabble teeth and the shaft speed. The arms move the charge inward to the center where it falls into the next hearth; here it is moved to the periphery from which it falls to the next hearth. This continues down the furnace.

The central shaft and rabble arms are of concentric double-duct construction, maintained cool by air blown through the central duct of the shaft. The air flows into the rabble arms and back into the angular space after which it passes out at one end of the shaft.

Many modifications and variations of the multiple-hearth furnaces are available commercially. Indirect-fired types are used for special applications. Muffle types are used for the recovery of gases evolved by decomposition, without dilution or contamination by products of fuel combustion.

Ore reduction types can be designed for the maintenance of a desired atmosphere in the hearth spaces.

Gas recirculation types can be provided for desired control of temperature and the atmosphere.

Fixed-Bed Equipment

The use of equipment containing a fixed bed of solids for operations involving the contacting of gases and solids is very common. The solids range in size from ⅛ in. to 3 in. and may be catalytic—as in the Houdriformer—or noncatalytic. Gas flow through the bed may be either upward or downward.

Fixed-bed processes have certain advantages over those in which the solids move continuously during normal operations. There is no appreciable solids loss due to abrasion, and equipment is not required to circulate solids or to separate solids to recover them from gas streams. Fixed-bed units possess considerable flexibility.

Among the inherent disadvantages of fixed-bed methods is the difficulty of adding or removing solids during operation. Cyclic operations introduce valving and purging problems that are complicated by very high temperatures and large gas volumes. Due to relatively poor heat transfer characteristics, excessive temperature gradients often exist within the bed.

In many cases the use of fixed beds is required by the very nature of the operation. In general the use of fixed beds is so well known that no special emphasis need be placed on considering it for new operations.

Batch Equipment

Trays and Compartments

Tray and compartment furnaces or dryers are generally restricted to the removal of unbound moisture or other solvent from a solid. Heated gas, generally air, circulates over the material until the solid reaches the required final moisture or solvent content. Such batch units are occasionally used for decomposition reactions but are not well adapted for the other operations cited above.

A large variety of equipment designs are available depending upon the nature of the material processed. Ceramics, lumber and similar materials are arranged in piles or on racks; granu-

lar materials, paste, slurries are placed in trays. Important factors in the operation of such equipment are the maintenance of a constant temperature and a uniform gas velocity for all the material being processed.

The use of tray and compartment dryers is usually limited to small batches of materials.

Tray or compartment dryers may involve the flow of gas either across or through the bed of wet material. Through-circulation dryers normally require much shorter retention times than cross-circulation units.

Muffle furnaces or dryers may be considered to be special designs of compartment units.

Pot or Autoclave

In general, batch furnaces and dryers may be of conventional or special design. Small batches of metals are conveniently melted in pot or crucible furnaces for non-ferrous metals melting below 1,200 deg. F; iron or steel pots are usually satisfactory. Higher melting metals require the use of refractory crucibles of fireclay alumina or clay graphite.

Autoclaves or "bombs" such as those used for the batch reduction of titanium tetrachloride, zirconium tetrachloride, thorium tetrafluoride and uranium tetrafluoride to metal, using reductant such as calcium, magnesium and sodium, are, in effect, batch solids-gas contacting units. In the case of the reduction of uranium tetrafluoride with magnesium to form uranium metal, the reduction proceeds at temperatures such that the chemical reactions involves the contacting of the uranium tetrafluoride with magnesium vapor to form molten magnesium fluoride slag and a molten uranium derby.

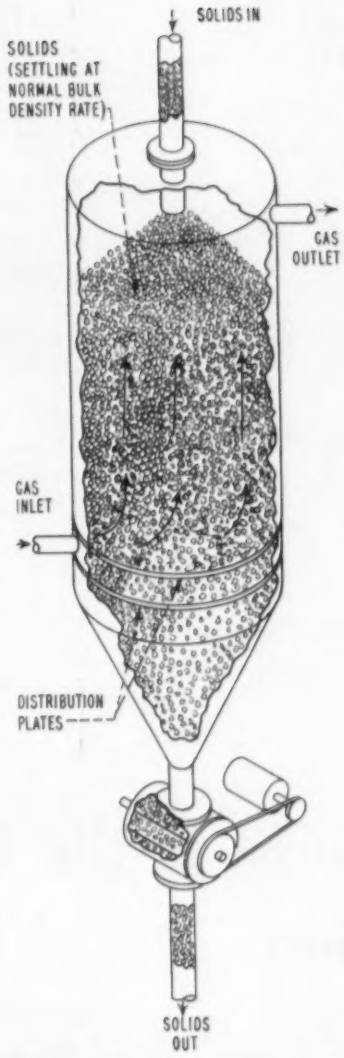
Retorts

This category might well be incorporated in the tray and compartment group. Vertical retorts are used for close temperature control and semi-continuous operation. Stock is fed at the top at intervals and product is withdrawn from the bottom in small batches, and occasionally from the side. Vertical retorts are used for the production and revivification of bone char, for the reduction of zinc ore and for the production of carbon dioxide gas by burning limestone.

Coal-gas retorts also fall within this general class. Coke ovens or retorts are a special design.

Special Designs

The so-called Mannheim furnaces involve special designs of circular muffle furnaces where sulphuric acid is reacted with sodium chloride to produce sodium sulphate and hydrochloric acid. It consists of a refractory hearth with a diameter up to 18 ft and a silicon carbide arch. Hot flue gases are circulated about this muffle, with the major portion of heat transmitted through the arch and radiated on the charge. The charge is worked towards the periphery as the reaction proceeds with the generation of hydrogen chloride gas. The gas is withdrawn to an adsorption system and salt cake is discharged at the periphery.



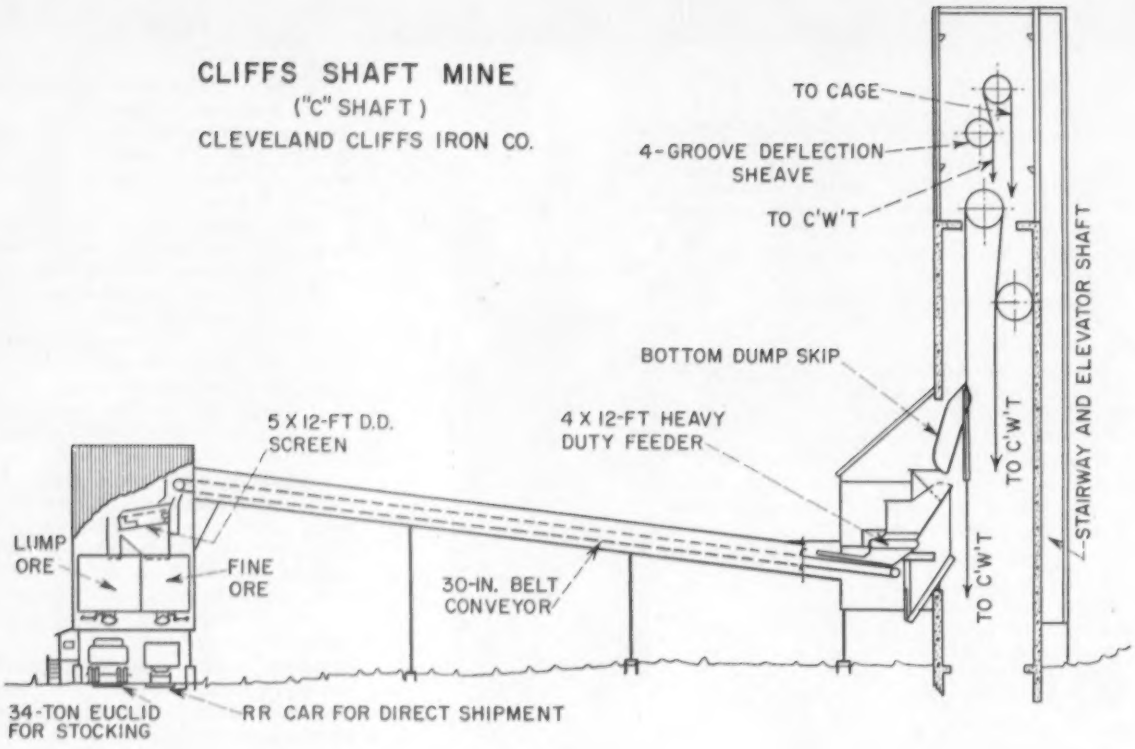
MOVING BED processes are one of metallurgy's most promising tools.

A wide variety of batch dryers with direct heat have been designed to operate on definite size batches of wet feed for specified time cycles. Most of these special designs involve variations of the tray and compartment dryers. The major characteristic of this type of unit, since it is batch, is the continued differential change in moisture content and temperature with time.

Batch indirect dryers are usually well suited for operation under vacuum. These include both agitated and non-agitated types. Agitated pan dryers operate atmospherically or under vacuum and are well suited for handling small production of practically any form of wet solids: liquids, slurries, pastes and granular materials. Vacuum rotary dryers have also found some use as batch units, with the material agitated in horizontal, stationary shelves. Vacuum tray dryers are widely used, particularly in laboratory and pilot plant studies, with heating carried out by contact with steam heated or hot water heated shelves on which the solid is placed. No agitation is involved in this type of unit.

Finally, mention should be made of use of infra-red or radiant heat dryers and dielectric heat dryers. The infra-red dryers operate on the principle of transfer of radiant heat, with the heat generated electrically by means of incandescent lamps or by gas-heated incandescent refractories. The use of infra-red radiation for removing water from solids is limited to the drying of thin film or sheet material. It is not generally applicable to handling large massive objects or materials where internal moisture flow is the controlling factor in the drying operation. In dielectric drying, the material to be dried is heated by placing in a strong electrostatic field produced by high-frequency voltage. While few industrial applications of this type of drying have been reported, many experimental studies have been made to determine its fields of application.

The induction heating principle has been used for many years in electric furnaces, especially for melting non-ferrous metals. The induction-type furnace makes use of the material to be heated as the secondary coil of a transformer; the primary coil is connected to the supply. Electronic or high-frequency induction furnaces are designed to heat only the shell of material, as in the case-hardening of gears and other areas subject to heavy wear. The physical phenomenon in the process of dielectric heating is similar to that in induction heating. In both cases a molecular friction or hysteresis is the probable origin of the heat conversion. In the case of dielectric heating, however, the charge functions as an insulator so that the flow of current is extremely small.



First Koepe Hoist in the U.S. Starts Operation

SUCCESSFUL INSTALLATIONS of friction-drive or Koepe hoisting equipment in Europe and South Africa have captured the interest of mining men in Canada and the United States where similar installations have been made. The Cliffs mine of the Cleveland Cliffs Iron Co., Ishpeming, Mich., was the first metal mine in the United States to install a unit. While a complete write-up on the hoist would be premature at this time, the company has kindly consented to release this brief preliminary information and accompanying design illustrations, showing the hoist in relationship to the underground shaft installation.

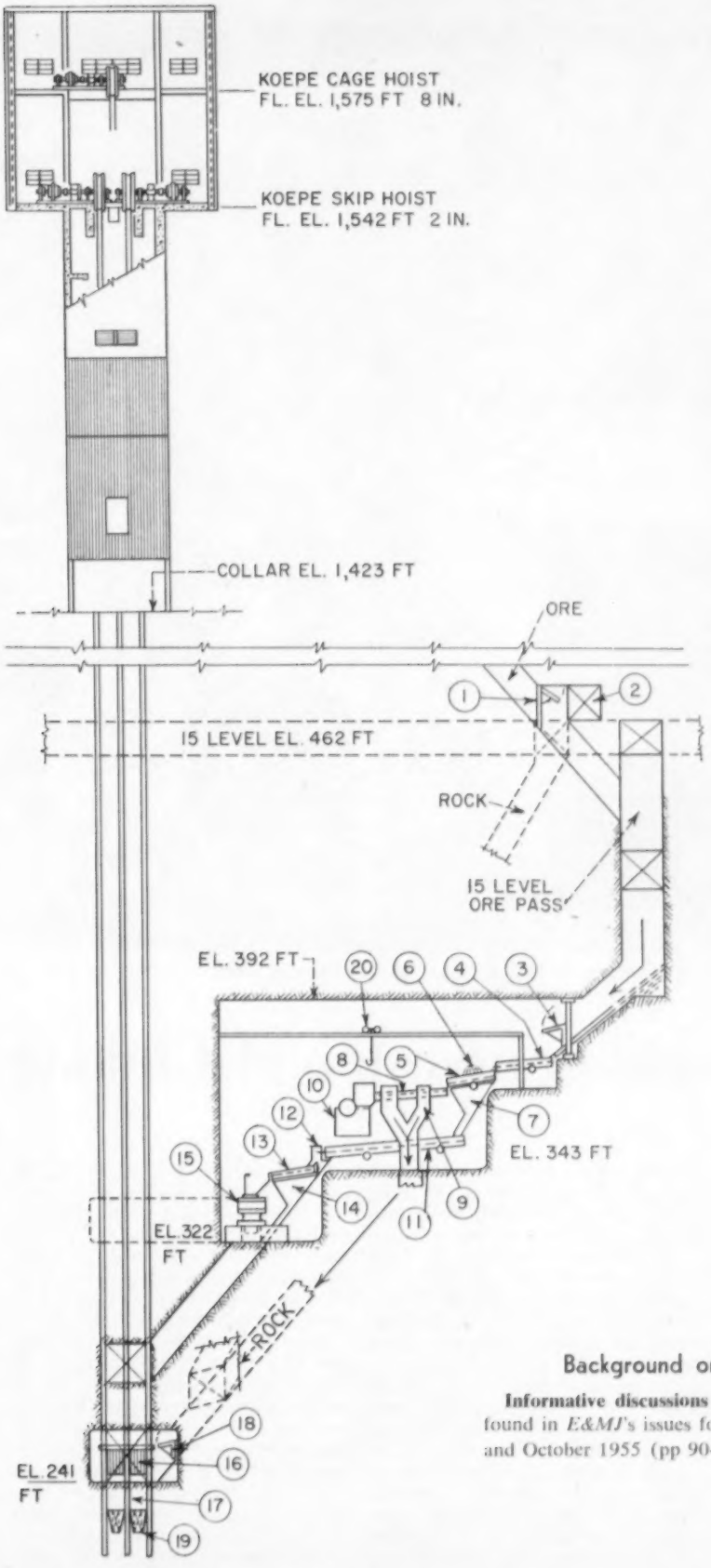
Trotter Coal Co., Morgantown, W. Va., has also equipped its main shaft with a friction-type hoist.

Facts about the hoist:

Drum diameter—skip hoists, 118 in.
Number of ropes—four
Rope diameter—1 in. (6x27)
Counterbalance weight—35,000 lb
Hoisting cycle for ore—22 skips per hr at present depth
Drive motor—1500 hp, dc, 600 rpm (max.)
Gear reduction unit (ratio)—9.231
Skip—bottom dump, 240 cu ft
Hoisting speed—2,000 fpm (max.)
Number of levels for ore hoisting—one at present
Is hoist fully automatic?—push button from loading station

Advantages in brief:

Increased safety in operation, due to multi-rope
Lower peak power demand
Smaller headframe possible due to smaller physical size and weight
Lower initial cost



LEGEND

1 Finger control gates
2 Top timber control sub
3 Finger gate
4 6x16-ft heavy duty feeder
5 6x12-ft S. D. screen, 4-in. square opening
6 Sprays
7 Chute, minus 4 in.
8 6x20-ft picking feeder, 5-ft wide feed
9 Rock chutes
10 42x48-in. jaw crusher 4-in. setting
11 5x40-ft vibrating conveyor-feeder
12 By-pass chute for lump ore
13 6x12-ft S. D. screen, 2-in. opening
14 Minus 2-in. chute and minus 4-in. by-pass chute
15 4-ft cone crusher, 2-in. setting
16 Finger gates
17 Measuring pocket, 220 cu ft
18 Rock pocket finger gate
19 Skip loading gates
20 20/5-ton traveling crane, 28-ft span

Background on Friction Hoisting

Informative discussions of friction drive hoists may be found in *E&MJ*'s issues for Mid-March 1955 (pp 42-43), and October 1955 (pp 90-95).

"Technology should be an instrument of peace and better living standards for more people."

Sr. Hector Boza, Vice President of Peru.

"Cerro de Pasco—A modern complex industrial system superimposed on a simple agricultural economy."

Robert Koenig, President, Cerro de Pasco Corp.

Cerro de Pasco's operations embrace an

How a Favorable Investment Climate

A. W. KNOERR

TWO EVENTS IN MAY UNDERSCORED the maxim that an undeveloped nation which provides a favorable economic climate for venture capital will be rewarded with increasing prosperity. These events were:

1. Press conference held in New York for the distinguished vice president of Peru, Sr. Hector Boza, who visited the United States to deliver the commencement address at his Alma Mater, the Missouri School of Mines and Metallurgy, and to receive an honorary degree for his great contributions to society.

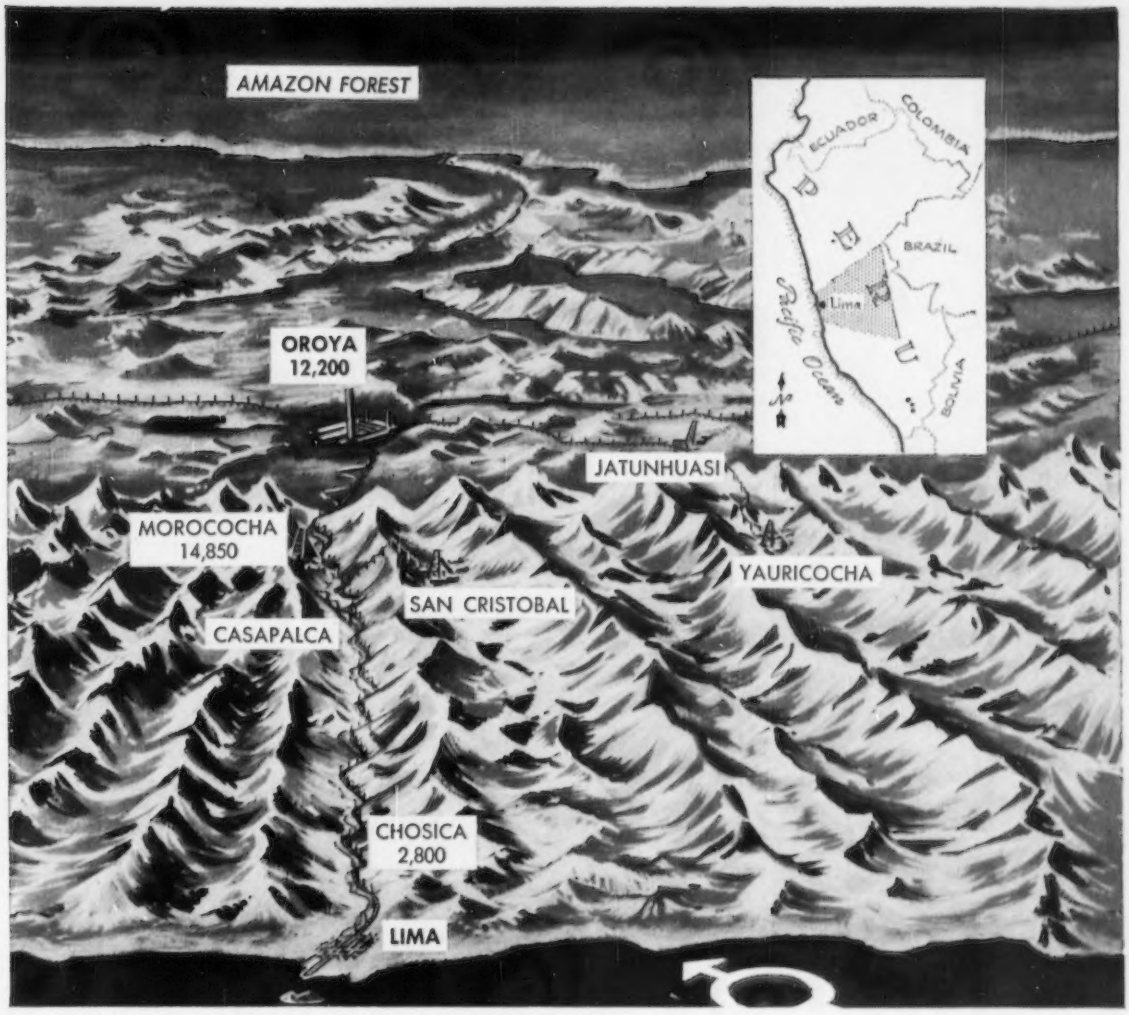
2. The annual stockholders' meeting of the Cerro de Pasco Corp., where Cerro's dynamic president, Robert Koenig, reviewed the company's Peruvian development and the diversification program.

At the press conference, Sr. Boza stressed the importance of Peru's long-standing friendship with the United States, and the liberal mining code which has attracted foreign investors to develop Peru.

As an example, he cited the impressive development of the previously dormant high Andean territory by the Cerro de Pasco Corp. This is shown in the map above. In exchange for raw materials extracted, Cerro has established living quarters, hospitals, schools, communication systems, power plants, a network of modern railroads and incomes for thousands of Peruvian citizens.

Reporters asked the vice president whether the June election in Peru might result in any change in policy toward foreign companies. In that respect he expressed complete confidence that the chief candidates favored continuing present policies. [In the free elections held in Peru, all people are required to vote. Failure to vote may involve certain penalties.]

Questioned on Peru's attitude toward Communism, Sr. Boza cited the record to show that Peru has not been receptive to Soviet overtures. He doubted whether forthcoming Soviet missions to South American would include a visit to Peru in view of Peru's



area of 8,000 square miles in the Peruvian Andes, and employ about 20,000 persons.

Has Benefited the People of Peru

staunch stand for Free World policies. The vice president also pointed out that Peru had contributed generous supplies of oil to the Allied naval ships which patrolled the west coast of South America during World War II.

The $200-million project now under way at the Southern Peru Copper Corp. property was cited as an example of the confidence which the United States and private investors have in Peru. This project is financed in part by an Export-Import bank loan, and by American Smelting & Refining Corp., Phelps Dodge Copper Corp., Newmont Mining Corp. and the Cerro de Pasco Corp.

Sr. Boza recommended an intensified exchange student arrangement to establish a better understanding between nations. He recalled that his interest in undertaking mining and metallurgy in the United States in 1907 was a direct outgrowth of his acquaintance with a young man in the Cerro de Pasco enterprise. Later he advised Oscar Benavides, son of the former president of Peru, to go to Rolla for a mining education. Oscar attended Rolla in the late '30s and later headed a large coal mining project in Peru. In view of Latin America's interest in the United States, the vice president said that the English language should be required in South American schools, and that the United States should introduce Spanish courses in primary schools to intensify the understanding between nations of the Western World.

Sr. Boza's record as a mining engineer and government servant is impressive. He attended the Missouri School of Mines for his mining degree, Illinois University for civil engineering, and the University of Wisconsin for post graduate work. Upon returning to Peru he headed the successful Boza Aizcorbe Hermanos gold and silver mining operation. Since 1933 he has served his government under General Benavides and subsequent administrations as ambassador, minister of state, senator and president of the senate. He has headed numerous special missions for his country and been awarded decorations by Belgium, Colombia,

SEVENTEEN METALS AND COMPOUNDS are produced at Cerro's complex Oroya smelter and refinery in the high Andes

France, China, Haiti, Germany, Spain, Venezuela and Peru.

The keynote of his commencement address at Rolla was an appeal for the application of technical education to the cause of world peace and better living standards for more people.

Sr. Boza's visit to the United States included a conference with Vice President Nixon, the State Department, a dinner held in his honor by the Pan American Society of the U. S., and a luncheon with Gov. Phil Donnelly of Missouri.

In public life he is often asked to approve various projects. When he needs additional information to make a decision, his answer is always, "You know, I'm from Missouri. You have to show me!"

Cerro's Stockholder Meeting

At the Cerro de Pasco annual meeting of stockholders in New York on May 9, Robert Koenig, company president, was asked to express his view on the June election in Peru. He replied "I can say this. The various candidates for the election to the presidency of the Republic of Peru are all people whom we know. The contest is largely between individuals rather than between ideologies, and we anticipate no change in the favorable economic atmosphere currently prevailing in Peru as a result of this election."

Before outlining the company's program, Koenig told the stockholders, "I would like to talk briefly about the part which Cerro de Pasco Corp. has played in the economic development of Peru. First because our 54-year experience in Peru offers a case history of interrelation of American private enterprise and foreign resources. Our experience may serve, therefore, to illuminate certain aspects of United States business performance abroad. Secondly, I hope that our more than a half century working partnership with people of Peru may act as a stimulus to increase the flow of private United States investment to Peru and to such other American republics as have established a climate favorable for foreign investment.

"By comparison with conditions that existed at the turn of the century, Peru has made great economic progress. When the Cerro de Pasco syndicate first became interested in Peru in 1902, modern machinery had just begun to replace primitive production methods in some branches of industry. Since that time, over-all economic development, particularly in the years following World War II, has been remarkable. Its vigorous economy, its free exchange policy, and its persistent encouragement of foreign investment have combined to make the Republic a noteworthy example of the free competitive enterprise system, not only in this hemisphere, but throughout the whole world.

"During the 19th Century, mineral production in Peru had been declining. With the advent of the Corporation and the ensuing transfusion of United States capital, technological and managerial skills, this downward trend was arrested. The part which Cerro de Pasco has played in the development of the country's vast mineral resources is evident from the scope of the corporation's highly diversified mining and metallurgical operations which embrace an area of 8,000 square miles in the Peruvian Andes, and give employment to a labor force of approximately 20,000 persons.

"The growth of this enterprise is more remarkable when one reflects upon the remoteness of its location, and on the fact that its development required superimposing a modern, highly complex industrial system upon a simple, almost feudal agricultural economy, and recruiting and training a labor force from a population that was predominantly agrarian and unskilled.

"The story of Cerro de Pasco's first 54 years in Peru is a story devoid of the cliché that extractive industries 'leave nothing but a hole in the ground.' For in place of 'exploitation' Cerro de Pasco has become a positive factor in many areas of Peru's economic and social advancement. The corporation, as an integral part of the country, has contributed to a better standard of living and of health, of education, transportation and communication, has established hospitals and community centers, improved the skills and productivity of Peruvians, and achieved cooperative, constructive management-labor relationships."

Other activities reported by Koenig were continuing progress in the $50-million program to improve plant and equipment in Peru; a 16% interest in the $200-million Southern Peru Copper Corp. project; organization of Refractarios Peruanos, S. A., and Explosivos, S. A., to produce refractory brick and explosives, respectively, in Peru; and the acquisition of oil and gas exploration rights on some 2.5-million acres of land in the eastern provinces of Peru. (Sr. Boza told the reporters that he was highly optimistic about possibilities of huge oil reserves existing in eastern Peru because of favorable structures and strata.)

The new Antamina copper property situated about 95 miles north of Cerro de Pasco has not yet been connected with Cerro de Pasco by road transportation. However, initial exploration and discovery work has been very encouraging and preparations are now being made to build an access road.

Tomorrow's copper was also yesterday's. This slab of chrysocolla-bearing sandstone and 5,000-year-old piece of smelter slag stand as mute testimony to Man's age-old struggle to get more copper out of the ground. His earliest attempts to win copper from ore outdate these relics from King Solomon's mine by several thousand years. Man started on native metal, found the oxide, and later turned to the easier-to-handle sulphides. The present price structure is right—and the long-term high-level use of copper leads to the conclusion that it's time to work the oxides again.

Oxidized Copper—Part I

Where Do We Get Tomorrow's Copper?

JAMES W. FRANKLIN
Assistant Editor

WORLD COPPER OUTPUT AND USE will set new records this year. By year-end 1956, output and use will probably pass 3-million tons of red metal a year. Even higher goals are forecast for '57, '58 and on through 1960.

All this activity points to one thing—we're using up our copper reserves at a tremendous rate. Where will we get tomorrow's copper? Estimates of Free World reserves show that we have about 100-million tons of red metal in the ground. That's only 33 years' ore supply at present growth. We think this estimate is low, because of the large number of oxide and sulphide deposits now being reported in Canada, Africa, South America and elsewhere. We'll come back to this in the summary of Part II.

The recent California Institute of Technology forecast shows that in the next 100 years the world population can be expected to increase tenfold. With this tenfold increase will come a rise in the demand for copper. Will it be 10 times the present level? Perhaps not, more likely it will be a 3-to-5 times increase. If it turns out to be such an increase in copper demand, we better be ready for it. Some copper men feel that now is the time to get ready, not tomorrow when we need it. Mining oxide copper is one way we can meet this demand. Some producers have already started.

After satisfying our curiosity with native copper from some streambed, we started civilization on its way by treating copper oxides some six thousand years ago. Down through the years, we worked the oxides and native metal, until the great, easy-to-handle sulphides were discovered. When we saw how easily the sulphides could be treated, we promptly forgot all about the oxides and dug into the sulphides and native metal.

Oxidized copper comes into the picture in several ways: (1) as pure oxide such as the great malachite deposits in the Belgian Congo; (2) as oxide caps on sulphide like Chuquicamata and others; (3) as mixed oxide-sulphide at Nchanga; (4) as minor, secondary mineral in Western U. S. ores; and (5) as phantom oxide in many assay sheets.

With the present favorable structure, we can afford to look into the oxides. Recently Ronald L. Prain, chairman, Rhodesian Selection Trust, stated that 35c a pound would be a reasonable price for copper. He feels that 35c copper would discourage substitution, and give a fair return to the miner. At the present price, we should be looking for ways to get more copper out of the ore by going after the oxide now going down to tailrace (Kennecott is doing it at Ray, and will consider it for Chino.)

Let's look at the oxidized copper situation.

Phantom oxide is the minor component in most of our Western ores. It can't all be called oxide. Some of it doesn't look or act like oxide mineral. Some metallurgists say it's partially oxidized sulphide slime that's been adsorbed on clay. It won't float. It can be leached but not as cheaply as

straight leaching of sulphide or oxide. Kennecott's going after it at Ray and has men working on Chino.

Let's take one Western producer as an example of this phantom oxide. They handle 50,000 tons of ore a day and discard 2 lb of copper in each ton going to the tailing pond. That's 100,000 lb or 50 tons of copper a day. Over a year it adds up to about 15,000 tons—more than Bagdad's total production. They're looking for a solution. And they're not the only ones out there trying to solve this problem. Project this loss at one property to the whole industry and the amount of copper that can be had is significant.

Yerington was built during an emergency and then only because the Government put a 25½c a lb floor under production. So it's safe to say that wire-bar can be made from 1% oxide ore for less than 25½c a lb.

It's cheaper to get this phantom metal while it's in the mill than to go back after it twenty years from now; mining, handling and crushing costs are paid. Only expense is separation and extraction. It costs a few cents a lb more to get this phantom oxide than it does to get the rest or to handle an ore like Yerington's. And, copper's long-range price picture shows that it's worth going after phantom oxide.

It's a secondary mineral when the oxide amounts to more than a few per cent of the total Cu available. This copper can be recovered by combined leach-precipitation-flotation, but this method gets expensive. Straight sulphide or oxide flotation is the cheapest way. A flowsheet using leach and scrap-iron precipitation costs about twice as much. And a leach-electrolytic plant shoots the cost up to 2.7 times that of a straight flotation mill.

Relative production costs for these routes, going from the lowest, to highest cost are: flotation; flotation-leach-electrolytic; leach-and-electrolytic-precipitation; and leach-and-scrap-iron.

What makes scrap-iron stripping so expensive? Getting the scrap-iron or the tin cans. Scrap or cans cost about $60 a ton—if you get them. The supply centers in the Western states have been tied up by one or another producer and there isn't enough to go around. Anaconda turned to sponge-iron at Yerington and Greater Butte as a substitute for cans. Sponge-iron costs almost as much to make as scrap-iron and it's only 50 to 60% iron. Going to sponge-iron may be the only route left open for a leaching plant. Kennecott is believed to be planning a sponge-iron plant at Ray.

Where oxide and sulphide occur and can be kept separate, selective mining and separate flowsheets are used. Chuquicamata, for example, mines and treats the two ores separately. While only 100-million tons out of the original 500-million-ton oxide cap remain, they can still keep the two separate. The same is true in some of our Western deposits. Selective mining and milling works well, until you get into the intermediate zone.

When the two are mixed throughout or you can no longer keep them separate, you have to take the ore as it comes and combine oxide and sulphide mill programs, just as at Nchanga. They float the sulphide, then float the oxide for leaching. After leaching, pregnant solution goes to electrolytic-precipitation and leache.l-tails go to a special flotation unit to recover the rest of the sulphide. It's been said that Nchanga's method is cheaper than straight leaching.

At Union Miniere du Haut-Katanga (probably the world's largest and richest malachite deposit) the problem is simple. Katanga floats the oxide, then leaches the concentrate for electrolytic precipitation. Again, this is cheaper than straight leaching; but the plant costs more.

Here in Part I, we'll consider only foreign copper deposits and get into domestic U. S. deposits in Part II.

In Part III of this article, we'll look into the methods used to extract the oxide, what can be used where and what the cost will be.

But where can you find oxide copper? How much is available? What kind of treatment does it get? Where should you look for more? We sent McGraw-Hill World News correspondents to ask the top mining men in 55 countries to answer those questions for you. Here and on the following pages we give you their answers in a country-by-country survey of the oxide copper resources of the Free World.

COUPLING NEW CONCEPTS of ore handling with the latest approach to milling, makes economic the low-grade deposits, like Kennecott's young Kimberly pit above. New mining techniques call for fast, mobile, trackless earth-moving units.

WHILE EUROPE'S RESERVES of copper are meager, Cyprus, isle of copper, has been working oxide and sulphide for ages.

AND IN ISRAEL, they're hard at work preparing the low-grade Timma orebody for exploitation. Plant will leach 1500 tpd ore.

European Reserves Are Meager

Austria. According to Dr. Bartosch, Austrian Mining Authority, some oxide occurs in border zones at Tyrol. Oxide at Schwaz and Brixless goes to sulphide flotation. Reserves were not indicated and the amount of oxide in chalcopyrite is small.

Belgium has precious little copper in any form. Odd occurrences are at Vielsalm and Salm Chateau; at Engilhoud near Liége; and at Vice, Colanhan.

British Isles. No copper of any kind remains.

Czechoslovakia has some oxide in porphyritic granite at Belones, near Nachod.

Denmark has no copper whatsoever, but on Greenland, deposits occur on the west coast. These deposits are small, but point to larger ones under the inland ice, according to Count E. Knuth-Winterfeldt, University of Copenhagen.

Eire copper deposits are being reopened by Canadian interests at Avoca, and maybe at Beara. Oxide and sulphide content is not known as yet.

Finland. Officials at Otanmaki Corp. and Outukompu Corp. are sure that no oxide orebodies exist in Finland.

France. No copper ore in Metropolitan France.

Germany. Oxide occurs at Rammelsberg, Richelsdorf, Stadtberge Bieber and in Saar-Nahe and Palatinum region. Small deposits can be found in Vosges Mountains and in the Black Forest. Very little is being worked and where it is worked, acid leach and cement copper methods are used.

Greece. Small scattered low-grade deposits in Epidaurus, Styrfaka, Limagardion, Agioi Theodorai, Lakonia and Antistari on Crete. Other spots include, Laurion, Chalkidiki, Alexandroupolis, Karystos Isle and Thassos Isle. Antistari is the only one being worked. It has only 1,000 tons, 3.5% Cu remaining.

Italy. Oxide was worked in 1913 to 1928, at Cala Bona mine, Alghero. Oxide cap has been used up and mine is in pyrite now. In the clayey soil of Sa Duchessa, Domus Novas in Cagliari province, oxide can be found. Azienda Minerali Metallici Italiani, a government corporation, treated this ore from 1936 to 1946. It contains calamine and copper. Ore runs 4.5% Cu, as chrysocolla and 9 oz Ag per ton. Milling costs put AMMI out of business.

In Sardinia, between Ogiastra and Ozieri, plenty of oxide copper can be found. Size and reserves are unknown.

Norway. No known deposits, only mineral specimens have been found in eruptive rocks of the Jolunheimen district.

Spain has no known oxide reserves.

Sweden. According to Professor Olaf Odman, Royal Institute of Technology, no economic deposits have been found. Oxide is a rarity here.

Switzerland. No deposits have been found, only mineral specimens, said chief mineralogist, Gallopin, Geneva, University.

Yugoslavia. Bor has 70-million tons, 1.24% Cu, with rich veins running to 5% Cu. Ore is mainly sulphide. At Majdanpek an oxide zone exists in the disseminated copper ore.

The Mediterranean Area Has Possibilities

Cyprus has oxide at Cyprus Sulphur and Copper Co. Ltd. property at Limni. Reserves have been estimated at 5.7-million tons, of which 1-million is oxide copper over the sulphide orebody.

Cyprus Mines is reported to use leach-precipitation-flotation to get oxide from Maviovouni, where ore runs 4.25% Cu. Cyprus Mines' Shouriotissa had 6-million tons, 2.25% Cu in 1922, but it is not oxide ore.

Egypt's ancient mines at Rukaita in the Sinai Peninsula were once worked for oxide copper. Lots of copper still remains to be exposed, according to Egyptian mining officials.

French Morocco. Malachite nuggets up to 100 lb can be found at Dogger,

east of Bon Arfa in the Eastern Atlas Mountains on the Algerian border. Reserves, estimated at 60,000 tons, 3.5% Cu, include bornite and chalcopyrite. Societe Marocaine d' Explotation Miniere will start mining this deposit this year. Ore is substitution in dolomite.

Oxide occurs at Tizi Moudou, Argana.

The High Atlas and Anti Atlas Mountains are good prospects.

Israel. Not far from site of King Solomon's mine, some 60-million tons, 0.7% Cu occur. Figures are based on survey of 200 acres at Timma, where some 12-million tons have been blocked out. Israeli sources say that 1,000 acres may be involved. Sources in the U. S. feel that the deposit may be smaller and the grade lower.

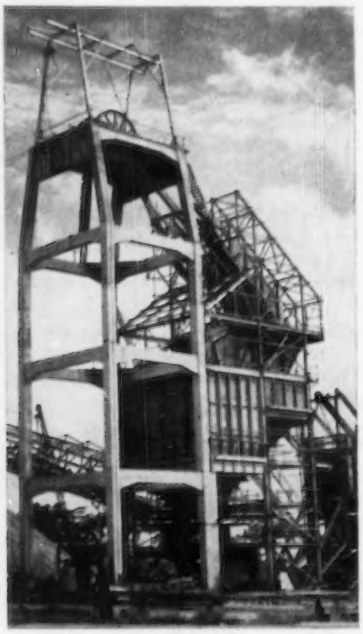
Cement copper precipitation plant to treat chrysocolla and tourquoise has been started. It will have 1,500 tpd ore capacity.

Lebanon. No oxides so far in the geological survey of the country now being conducted.

Spanish Morocco has no known deposits.

Turkey has many scattered copper showings, according to C. W. Ryan in his *Guide to the Known Minerals of Turkey*. Ryan does not define the kind of copper in these deposits and it would seem that Turkey would be a good place to look for copper. Apparently this is not so—Newmont Mining Corp. has had a subsidiary exploring this country for years and admits that nothing worthwhile has been turned up so far.

UPGRADING MALACHITE ORE is a simple crushing and washing process at Union Miniere du Haut-Katanga's Ruwe open-pit. Ore is a soft, yielding breccia.



NEWEST Rhodesian underground mine is Chibuluma with 7.3-million tons ore.

Africa's Resources Are Vast

Belgian Congo. Most mines have used up their oxide. Shituru and Shamitumba work some on small scale.

In Kolwezi, four mines still work oxide: Kamato and Kolwezi have oxide over sulphide, Musconi and Ruwe are in oxide, with sulphide below. Ruwe is a freak. It is the world's largest malachite open-pit. Ore can be processed by washing alone.

Kolwezi treats 200,000 tons ore per month, using palm oil flotation and acid leach on concentrate. Leach plant is at Shituru where copper and cobalt are recovered electrolytically.

Lubumbashi is mostly sulphide with some oxide.

Shituru handles 111,744 tons concentrate a year, all oxide.

Panda produced 646 tons oxide concentrate in 1954.

Kupushi is all sulphide.

Almost all the copper in Congo lies in Miniere du Haut Katanga concession. Some malachite found as far south as Leopoldville, but not a trace so far has been seen in the northern Congo. Miniere's copper reserves can be conservatively estimated at 10-million tons metal, with considerably more potential ore.

Eritrea has no known oxide deposits, but a 400,000 ton, 3% Cu orebody with possibly 2-million tons, 1.75% Cu available can be found at Udi Rasci, 32 miles south of Asmara.

Ethiopia has many known, small, scattered occurrences, but no major mining has ever been attempted.

French West Africa. Societe des Mines du Cuivre de Mauritanie has copper deposit, but no data is available.

Kenya has only one copper occurrence to date: the Macalder Cu-Pb-Zn-Au-Ag-Co complex orebody.

Northern Rhodesia. This country contains lots of sulphide, but enough oxide occurs mixed with the sulphide to justify special treatment. Nchanga has oxide at all depths. The rest have

oxide in the cap. The Copperbelt is 140 long and about 40 wide.

Chibuluma has 7.3-million tons, 5.23% Cu, will produce 19,000 tpm metal from underground mine.

Magundi Copper Mines and Minerals has a deposit showing 300,000 tons, 4% Cu at Mtuga.

Kansanshi Copper will start mining again after 42 years lapse. Mill will treat 12,000 tons per month, 3.5% Cu. It has considerable oxide and oxide-treatment has been the main reason why the mine has been idle so long.

Nchanga has chalcocite and malachite, chrysocolla and other oxides. Total reserves exceed 136-million tons, better than 2.4% oxide. Sulphide zone runs 2% Cu. Nchanga floats sulphide, then the oxide. It leaches the oxide, then floats the leached-tailings for residual sulphide. Leach solution is stripped by electrolysis. Cathodes run 99.9% Cu.

Raymond Brooks, the man who found Nchanga, says that there is still plenty of the same material to be uncovered in the same area. He is in Rhodesia, looking for more copper.

Total ore reserves in the Copperbelt probably exceed 600-million tons, 3.7% Cu. Roan Antelope Mines holds some 90-million tons, 3.27% sulphide Cu. Rhokana Corp. Ltd. reserves at Nkana and Bwana M'Kubwa hit 100-million tons, 3.2% Cu. Rhokana also has some 92-million tons, 3.6% Cu in the Bancroft Mine, near Nchanga on the Congo border. Bancroft's Konkola orebody has 32.9-million tons, 2.48% sulphide Cu and 0.45% oxide copper. Their Kirila North and South orebodies hold 46.7-million tons, 4.39% Cu. Kirila North runs 0.5% oxide.

Baluba mines has 70-million tons, 2.68% Cu. It is not being mined.

Chambishi has 25-million tons, 3.46% Cu. It is held in reserve and is mostly sulphide. Mufulira is sulphide.

A recent copper strike by Magundi Copper Mines assays 6- to 16% Cu along a two-mile strike, in the Fort Jameson area.

Rhodesian Broken Hill has 1,723,000 tons proven, 1,304,000 tons indicated. Reserves do not include surface stockpile of silicate copper. Mill has not been designed.

South West Africa. Tsumeb contains considerable copper and lead oxide. Cu is malachite, azurite and tennantite. They float sulphide and oxide separate. Recovery is 93% Cu, plus Pb-Zn. *Materials Survey* stated that Tsumeb had 567,106 tons, 8% Cu in the 14th to 20th level area (1952). Also they had estimated 330,000 tons, 5% Cu dump ore on hand in 1952. Latest report is that Tsumeb has 106,908 tons blocked out (1955).

Southern Rhodesia has no known oxide occurrences at this time. Messina (Transvaal) Development Co. is spending 14-million to make it Mollie mine the largest Southern Rhodesian producer. Reserves are 16-million tons, 1.6% Cu.

Sudan has oxidized ore outcropping and extending to 100 ft deep over the sulphide orebody at Hofrat en Nahas. It was worked for centuries, but abandoned during the 1882 revolution.

Tanganyika has trace copper here and there, but no workable deposits to date. Mpanda is Pb-Cu ore.

Union of South Africa. Some oxide noted at Van Rhynsdorp. Deposits at Messina and O'okiep show small oxide. In 1951, Messina's reserves were set at 3.7-million tons, 2.15% Cu. O'okiep has 15-million tons, 2.55% Cu during the same period. O'okiep has leaching plant for oxidized dump ore.

Uganda. Kilembe Mines Ltd. has 17-million tons, 1.88% Cu. This copper and cobalt ore will be milled at about 1300 tpd. Ore is similar to that found in Northern Rhodesian deposits.

The Americas Have a Lot of Deposits

Canada. No oxides of any significance in the many sulphide orebodies discovered to date. Canada's known, published total reserves in 1953 (the last complete survey) were set at more than 2-million tons of copper metal, according ,to *Canadian Mining Industry, 1953.*

Bolivia. In an area 350 miles long and 50 wide, between Corocoro, Pacajes and Sud Lipes, Potosi, to the south, many deposits exist. According to Direccion General de Minas' engineers, large chrysocolla desposits are known; but as yet have not been explored due to lack of transportation.

AS&R has a 300 tpm copper plant at Corocoro. Rio Corocoro is oxidized, 100 ft deep. A leach plant in 1919 followed a flotation plant added in 1918. Plant is leased to Bolivia government.

Brazil. In Biaha, near town of Bonfim a low-grade deposit lies idle.

Chile. Unworked deposit at Sagasa, 108 km east of Iquique, holds 7-million tons, 2.5% oxide copper. It will be worked by segregation process. Crushed ore will go to 600 deg C kiln with coal (2% of charge) and NaCl (0.2% of charge). Copper metal deposited on coal will be floated to a 60-70% Cu concentrate.

At Mantos Blancos, 35-million tons, 3% Cu deposit exists. It was once worked in a small way by leaching.

Experiments are now being conducted on 6-million tons, 2.5% Cu orebody at Huiquitipa. Ore is a conglomerate with sulphide, oxide and carbonate. Hochschild plans 1,000 tpd leach plant to yield 6,500 tp year metal from 2-million tons, 2% oxide Cu.

Compania Cuprifera Sagasca has 8-million tons, 2.5% ore, plans 100 tpd float and leach plant. Sagasca is headed by syndicate that includes Rosario Mining Co.

Mining Credit Bank plans 100 tpd slime plant at El Salado to handle 3-4% Cu oxide from dump piles.

Mantos Verde option, held by Societe des Mines de Charriere, is a large low-grade deposit (several million tons). A 500 tpd mill is planned. It will leach ore with SO_2 in brine from El Salado River to recovery Cu from hematite.

Another 3.5-million tons, mostly sulphide with some oxide, can be found at Copaquire. This was worked up to 1946 by leaching.

Lo Aquirre, west of Santiago, contains 9.5-million tons, 2.5% Cu, mixed sulphide-oxide. Work will start soon on this deposit.

Braden Copper Co. had about 200-million tons, 2% Cu (1952) with very minor oxide, only the sulphide is being treated. Braden has an acid plant.

The 35 tpd contact sulphuric acid plant at Antofagasta will be ready shortly. It was built by Corporacion de Fomento to supply acid for local small mines.

Cerro de Pasco recently took option on Compania Minera Rio Blanco property near Santiago. Reserves drilled to date are 27.8-million tons.

El Salado will build a 100 tpd slime plant to handle oxide copper (3-4% Cu). They have a 200 tpd flotation plant.

Fundicion Nacional de Paipote will

MORE THAN 80 MILES of railroad serve Chuquicamata's open-pit, where more than 600-million tons have been taken out of this mile-and-a-half long, terraced pit.

build a contact acid plant at Paipote smelter to provide acid for leaching low-grade ores that Paipote cannot smelt. It will be on stream in two years as will Paipote's leaching plant.

Chuciquimata runs 1.7% Cu in oxide zone. Only 100-million tons remain. Sulphide below oxide appears to be inexhaustible. Total reserves were estimated to be over 1-billion tons (in 1950) when they stopped drilling. Grade is 2.15%. Oxide is leached at minus ¾ in. in 14 sulphuric acid vats and precipitated by electrolysis at 83.75% recovery. Current efficiency is 85-92% on 20-25 amperes. Reverbs yield 400 tpd copper on fuel oil. Chuqui yields 265,000 tons copper a year with planned expansion included

La Africana (Anaconda Co.) has 2-million tons ore, all sulphide.

El Salvador (Indio Muerto) has no oxide, so dressing will be much simpler than at Potrerillos where oxide occurred. El Salvador will be underground.

Potrerillos (Anaconda Co.) has some oxide, but the entire orebody will be gone in five years or so. They leach the oxide and float sulphide.

There are some thirty small oxide leaching plants around Antofagasta.

Toquepala has 1-billion ton, 1% Cu and plans a 30,000 tpd mill. It is not oxide.

Hochschild has 70 tpd mill at Copiapo, once used niter cake to leach.

Punta del Cobre will increase mill capacity to 1000 tpd by adding leach plants at Cobre and Domeyko.

Colombia. Nothing of any size so far. Some small and scattered ones run 1% Cu in Cauca department.

Costa Rica. A report of ore samples running 65% Cu has been made. This is the first discovery of copper in the country. Kind of copper has not been published.

Cuba. Old Spanish mine, El Cobre, outside Santiago was once worked for oxide by Cuba-American syndicate. According to Father Charles Berry of Villanova College, Oriente province is a good place to look for copper.

Dominican Republic has no known deposits other than the 300-year-old Spanish mine on the heights of the main Cordillera. This mine hasn't been worked since the Spaniards left the country.

El Salvador has no recognized deposits, but the area near Santa Ana department on Guatemala border looks interesting.

Mexico. Political situation has hampered past growth of mining here. Mexico still ranks fifth as a world copper producer. Many oxide deposits known along the Pacific Coast. Outstanding is that of Compania Minera de Santa Rosalia, S. A. (half government-owned). Ore outcrops in many places. Average grade is 4% Cu. In addition, many tons oxide tailings remain to be treated. This was the old El Boleo Co. property in Baja.

At Santa Rosalia (200 tpd) ore is crushed, kiln dried, mixed with pyrite, gypsum and silica, then smelted in reverb. Matte goes to Pierce-Smith converter. Plant yields about 160 tons blister per month. Ore is mostly chalcocite.

Asarco, S. A. considers their Inguaran, Michoacan State property, as uneconomic and low-grade. Asarco (American Refining & Smelting Co.) treats some oxide at San Luis Potosi smelter.

Cananea Consolidated Copper Co. leaches old worked out areas with mine water and precipitates cement copper. Cananea also feeds some oxide from the open pit to the smelter as silica flux. Ore is mixed oxide-sulphide.

Anita Copper mine, Sonora, has 65,000 tons, 7% Cu reserves. Oxide caps chalcopyrite above 300 level.

Azteca Copper mine, Sonora, has oxide down to the 50 level. No reserves stated, but the vein is up to 25-ft wide.

Las Vigas mine, Chihuahua, holds possible 100,000 tons; probable 50,-000; and proven 5,000 tons, 4% Cu.

In addition, oxide occurs at mines in San Mateo and Mineral del Carmen, Durango; Fresnillo and Rio Tinto, Chihuahua; La Quimica, Mexico; Campo Morada, Ajuchitlan and Querrero (100,000 tons), Chihuahua; Ameca, Jalisco; Ojocaliente, Zacatecas; and El Boleo, Baja California.

Boleo deposits are thin, dipping, tabular orebodies. There are five layers of ore separated by conglomerate or tuffaceous sandstone. Oxidized zone extends some 25 meters deep. Each bed averages 80 cm thickness and runs 4.7 to 6.3% Cu. Many million tons of 1 to 2% Cu still remain.

Most of the ore taken out since 1886 was smelted direct. Some mines still contain ore up to 19% Cu. Some 56 shafts can be found in the area. Cut-off point for direct smelting ore was 3 to 3.5% Cu. Smelter recovery was only about 87%. This ore cannot be upgraded via heavy media. Leach and float might work here, but ore contains up to 6% Mn.

Boleo reserves are 300,000 tons high grade; 2 to 5-million tons, 2%; and considerable more at less than 2%. Over 900,000 tons dump and smelter slag, 1.5% Cu also remain. This area looks good for further prospecting for copper and manganese.

Moctezuma deposit of Phelps Dodge is sulphide. They leach-in-place worked out underground areas.

Peru. Many deposits here show

some oxide. Area between Ica (south of Lima) and Tacna (near Chilean border) contains many small deposits running up to 4% Cu. Cerro de Pasco region has abundant, but small, oxide orebodies.

A 50 tpd leach plant was put up by Compania Minera Chapi, S. A. at their property 65 km south of Arequipa. They will leach chrysocolla. Reserves are 80,000 tons, 3.5% Cu; with a million tons more possible.

Cerro de Pasco deposit at Antamina contains some 20-million tons, 1% Cu., has only minor oxide.

Cerro has also re-opened the San Cristobal vein deposit, which has estimated 1-million tons, 2% Cu mostly sulphide. Tintaya has oxide zone over sulphide, but is being held in reserve by Cerro.

Standard Ore & Alloys Corp. has option on 9.5-million tons, 3.5% Cu at Landa, near Colpe River in Cusco area. Ore is sulphide with oxide cap.

Oxide occurs at Morococha.

Puerto Rico. Old Keystone mine, near Rio Blanco, Naguaho, contains oxide. At Ceiba Norte, Juncos, a 750,000 ton magnetite deposit runs 1 to 2% Cu oxide. Some shipments have been made since 1952.

About 60 tons hand-picked ore came from a deposit at Vega Pasto, Morovis. Size has not been determined, but grade is said to be about 3%.

Another orebody of undetermined size occurs at Aquada. Near Minillas, San German, a 3-ft vein runs 4% Cu.

Naguabo is a good prospect.

Venezuela. All known oxide has been worked out at this time.

Asia Is Still To Be Explored

Australia. Some oxide ore can be found in Western and Northern territories. In 1954 4,748 tons, 8.3% Cu came from Western deposits. No studies have been made on this ore. Mining is a part time job for shepherds. Oxide is ground and sold for agricultural use.

Whim Creek mine produced concentrates from Copper Hills, Pilbara.

Mt. Lyell area, Tasmania, once held considerable oxide, now has only sulphide. Reserves estimated to exceed 40-million tons, 0.7% in the open-pit.

China has oxide copper at Fenghsien, Kaalochun, Shansi, Tungchiehchang, Tayeh, Suinin and Fukien. No data is available.

Hong Kong. Nothing here.

India. Unworked, scattered deposits occur in Madhya Pradesh, Rajasthan State, and in Ras Koh and in Baluchistan. Reserves are unknown. Oxide also occurs at Sikkim and Singhbhum.

Japan. Oxide occurs in tuff, sandstone, slate and mudstone at Sawaguchi mine, Kami Kumanomura, Isekawa-ken. Size is unknown. Some 226 tons, 1.7% Cu was taken out in 1953 and treated in a cement copper plant.

Philippines. From Paul A. Shafer, mining engineer, came a very good report on this country. There are many deposits, but most are thin. Oxidation here is shallow, due to high annual rainfall and high ground-water table. Silicates are uncommon, except at Sipalay, Negros. No leaching is being done on the islands so far, but several companies may start it.

Spanish worked oxide at old mine at Lepanto, Luzon; but it is not important now.

About 40 miles north of Lepanto a very high grade deposit, as yet undefined, is being explored. It is in the Cordillera Central.

Oxide was once worked at Nyak and Syoc, south of Lepanto.

Pasuquin, Ilocos Norte and many other places in northern Luzon show oxide. These prospects have not been developed; except at Pasuquin.

Only minor oxide occurs in copper deposits in Zamales Range on Luzon.

Undeveloped oxide ores are noted at Nueva Ecija, Nueva Viscaya and Quezon provinces.

In western Paracale district, Cumarines Norte, several very high grade, undeveloped spots occur. Oxide deposit at Marinduque is large and undeveloped. Several scattered deposits have been noted on the west coast of Albay; at Camarines Sur; at Catanduanes; and on northern Masbate.

Direct shipping ore has been taken out of Antique from time to time.

Drilling continues to add reserves to 9-million ton orebody at Sipalay, Negros, where 1-million tons oxide has been blocked out. Oxide will be stockpiled and treated separately later on. Several other oxide outcrops have been seen in the area.

At the Atlas Consolidated Mining & Development Co. property on Cebu, the cap is oxide. Ore runs up to 2% Cu in the oxide zone. It is not being treated now, but being set aside (some 250,000 tons already) for leaching at a later date. Total reserves at Toledo are 68.5-million tons, 1% Cu. About six kilometers away, another large, undeveloped deposit occurs at Pina-Barot. Cebu appears to have considerable oxide and native copper as well as sulphide.

Leyte and Mininao hold undeveloped scattered showings. Recent strike at Bacacay, Samar was large chalcocite body with little or no oxide.

Rajasthan has many occurrences of oxide copper. In the places noted below it has been mined in past centuries by primitive methods and leached with sulphuric acid. Leach liquor was dried in the sun to produce copper sulphate.

M. L. Sethi in his *Mineral Resources of Rajasthan* (1956) states that oxide occurs at: Singham, where several million tons of slag remain in addition to ore; Kho-Dariba in chalcopyrite; Delwara Kerovli, where one malachite deposit runs 6.8% Cu; Debari has abundant oxide; Bidasar; Churu; Bikaner; Jalawar; Sainpuri; Salumber; Dungarpur and Bhim in Udaipur.

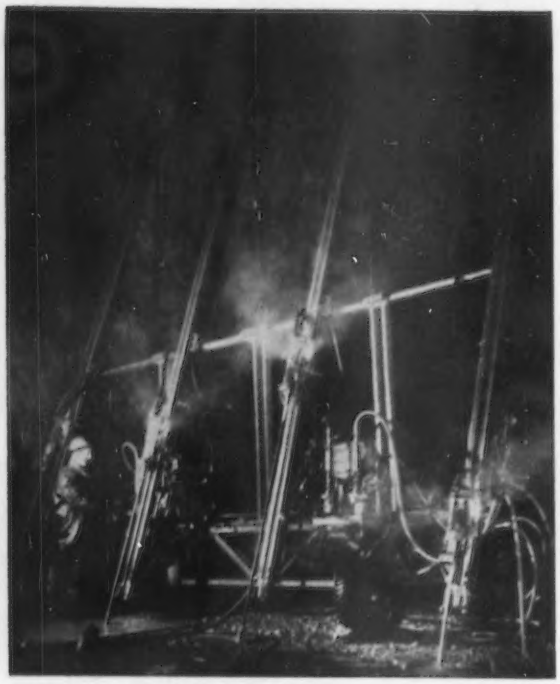
Russia. Premier Bulganin accused mining factions in that country of falling down on the job as far as oxide copper is concerned. He didn't say anything about reserves or deposits. He said that the U. S. was making better use of an oxide treatment method developed by a Russian (who else?), than the Russians were. The *Materials Survey, Copper,* (1952) by the National Security Resources Board states that Russia had 15.8-million tons recoverable metal in 1932.

Adding Up The Score

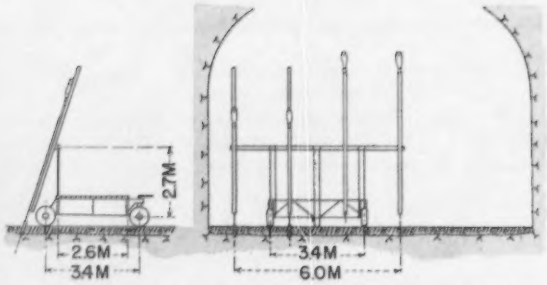
Ignoring the primary sulphide orebodies not mentioned above and those deposits where both grade and size are uncertain, we estimate that the known Free World copper reserves exceed 76-million tons metal. This does not include the U. S. We'll get to domestic U. S. reserves in Part II.

In Part III, we'll discuss how to treat oxidized copper.

This survey of oxidized copper will be reprinted in full when all the sections have been published.



SMALL JUMBO was designed for wet section of tunnel and used water flush. Since only four drills were used on jumbo itself, two wagon drills were required to give complete line of drill holes across full tunnel cross-section.



TWO-THIRDS WIDTH was covered by Type II jumbo.

For Wet Drilling . . . Or

Type II Jumbo was built to cover only two-thirds of tunnel width. Remainder of drilling was done with two wagon drills. Jumbo was mounted on rubber wheels and was moved along tunnel by air winch. Four Atlas Copco chain feeds (Type BMM 41RB) having an approximate feeding length of 17 ft were used with Atlas Copco rock drills (Type BBC 41RB). Drill steel used was 1 in. hexagonal with 41 mm (1.6+in.) bit and 18⅓ ft in length.

Holes were drilled with water flush as rock in section of tunnel where this jumbo was used was traversed by a water-carrying layer. Chips became like tough dough which air was incapable of blowing clear of drill hole when drilled dry.

Problem of muck and mud on bench was solved by first drilling through it with a quadrant crowned bit 2⅛ in. in diameter with air blowing. A 2-in. pipe was then inserted and drilling continued through it with water flushing.

Hole pattern is shown in illustration near end of article.

Drilling was carried out by two men in two shifts.

Two Jumbos Speed Bench Drilling In Swedish Tunnelling Project

S. B. DAHLSTROM
and
OLOF PERSSON
AB Skanska Cementgjuteriet
Stockholm, Sweden

NEW TYPE OF ROCK DRILLS and jumbos for tunnel benching, developed while driving the discharge tunnel for the Gulsele hydro-electric power station in Sweden, give improved drilling rates and permit multiple-machine driving, viz. one man operation of several rock drills.

The station is being constructed for Gulsele AB. Contractor is AB Skanska Cementgjuteriet.

Results show that, whereas the drilling footage per man per eight hours shift was previously estimated at about 180 ft, one man operating a number of machines can now drill about 525 ft. Of course, there is the cost of the jumbo, but if one is to be used for a larger job or on a number of projects, this additional cost is rather small compared to saving in wages. This is apparent from standards which Skanska Cementgjuteriet uses for work of this type:

Rock drills (including equipment for air and water intakes, as well as spares, and wages for repairs)..... About $0.015 per foot drilled

Drill steels..... About $0.030 per foot drilled

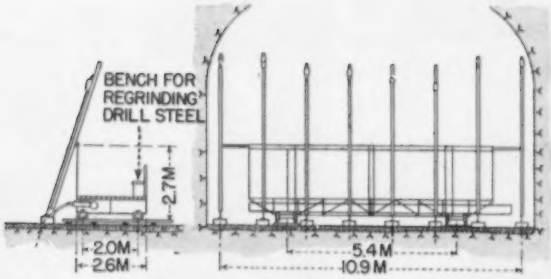
Compressed air (including compressors, air and water pipes)..... About $0.027 per foot drilled

Wages...About $0.074 per foot drilled

These figures show that wages make up for more than half of total cost per drilled foot, which means that a reduction in number of man-hours is a considerable saving.

Driving a top heading and removing remaining rock by benching, is a method of rock tunnelling that has been adopted more and more in recent years. Some reasons for this development are: in many cases tunnel cross section is so large that it has to be divided up rather than worked by face method; in bad ground, roof is more accessible for easier placing of support; and desire to avoid three-shift operation, where possible, has resulted in even an average size tunnel being divided into a small top heading which can be mucked in one shift and a bench which can be mucked continuously.

Bench driving efficiency has therefore become especially important. Down-hole drilling from upper heading permits mucking at same time, thereby cutting down over-all time of driving tunnel. Short delay blasting, enables blasting to be carried on without mucking out bench blasted by earlier rounds, thus making blasting and mucking operations independent



FULL WIDTH of tunnel was drilled by Type I jumbo.

For Dry Drilling . . .

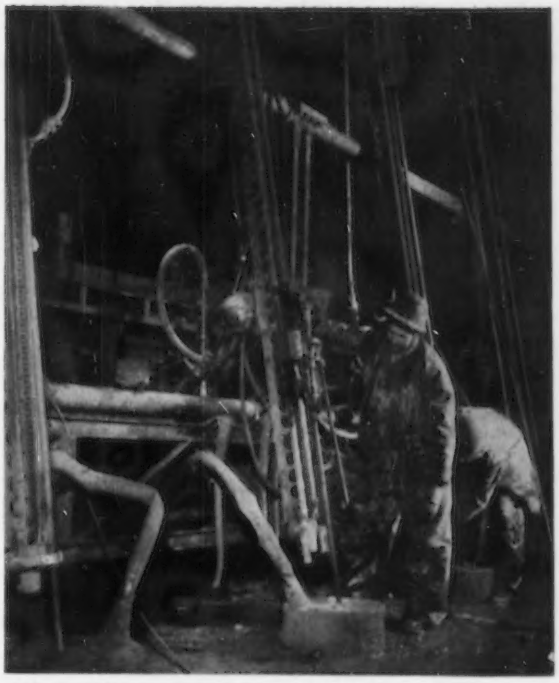
First jumbo, Type I, was made to cover whole cross-section. It traveled on double tracks and was moved by means of an air winch. Eight Atlas Copco chain feeds (Type BMM 41K) having a feed length of 17 ft were used with Atlas Copco rock drills (Type RH-656-2L). Chain feeds and rock drills were operated from front part of jumbo. To remove risk of accidents if and when drilling "missed holes," regulation of the throttle valve was operated from a "safe" position some distance behind jumbo. An air receiver (approximately 70 cu ft) was also mounted on jumbo, with pipe and hose connections to chain feeds and rock drills. Drill steel used was ⅞-in. hexagonal, with 32-34 mm (1.3±in.) bit diameter. and 18⅓ ft in length.

Holes were drilled with air flush. One of the difficulties in dry drilling is to render dust harmless. But after a lot of experimenting, this problem was solved. A steel cap was placed over point where hole was to be drilled and held in position by suction caused by a foam rubber disk on the underside of cap. Drill steel was inserted through a rubber-sealed hole in top of cap. When drilling, chips were blown from rock drill up through drill hole into cap where most of chips and coarsely-powdered rock piled up around hole, preventing water from penetrating into drill hole. Rest of dust passed through 2 in. rubber hose to wetting chamber where water sprayed through jets. Sludge was then carried to tunnel wall by means of drainage pipe.

Drilling through "mud layer" (0.7 to 2 ft thick) on uncleaned and water saturated bench was done without any difficulties. When drill steel reached rock, hole through the "mud layer" was hardened by dry cuttings so that it remained intact for a number of days in spite of water. But to ease charging, thin-walled pipe was inserted through "mud layer" soon after drilling. Pipe was removed prior to firing.

Hole pattern is shown in illustration on next page.

At beginning, drilling was performed by two men in three shifts. Poor rock, however, made it necessary to employ an extra man per shift so that jamming could be prevented by better supervision of chain feeds and rock drills.



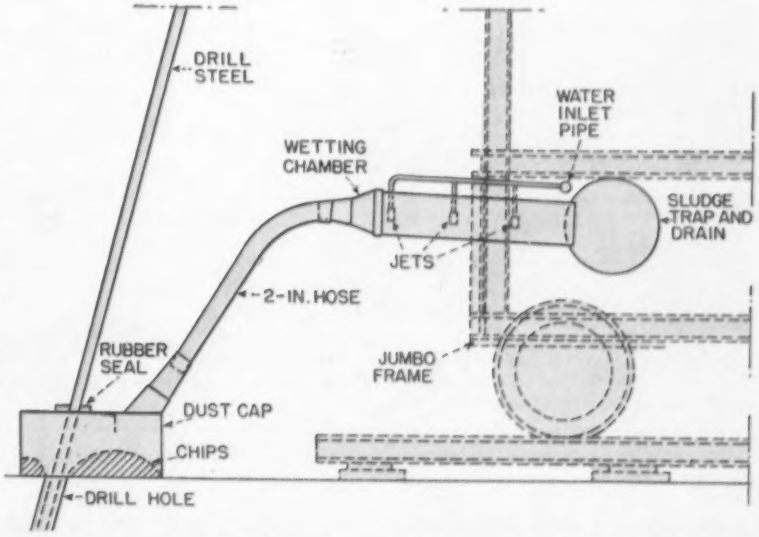
BIG JUMBO, on track, carried eight air flush drills. Both on this jumbo and the later water flush model, machines as well as carriage were designed to increase drilling rate and to permit one man to operate a number of rock drills.

of each other. And the new types of rock drills and jumbos described in this paper have been designed to reduce drilling costs.

At Gulsele, rock is mainly two types of granite—medium course grey and fine granular light. It is cut by many fissures in different directions and traversed by a number of small as well as large brecciated zones with gouge-filled fissures.

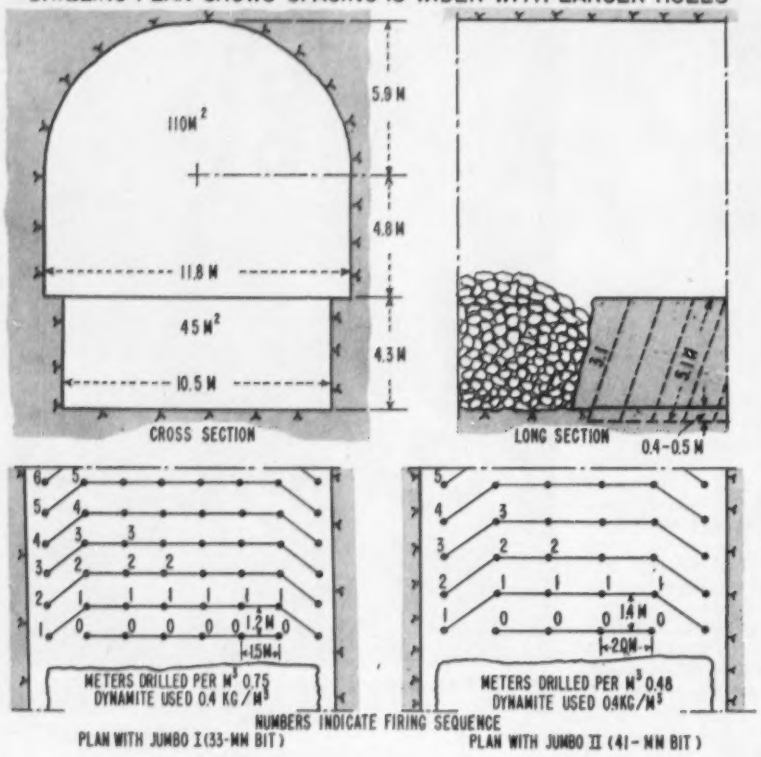
The poor tunnelling quality of the rock is evident from the fact that about 1,970 ft of total tunnel length of 6,900 ft had to be reinforced—1,320 ft by complete concrete lining, which is rather unusual for Swedish conditions. The nature of the rock, in spite of a number of experiments, made it impossible to drill to the required depth with hand-held machines; and pusher legs could not drill at more than half the speed of jumbos. When judging the performance given here,

(*Continued on next page*)



WATER SPRAY traps dust in collector on Type I jumbo. Sludge flows to ditch.

DRILLING PLAN SHOWS SPACING IS WIDER WITH LARGER HOLES



Larger Machines Give Faster Speed Performances

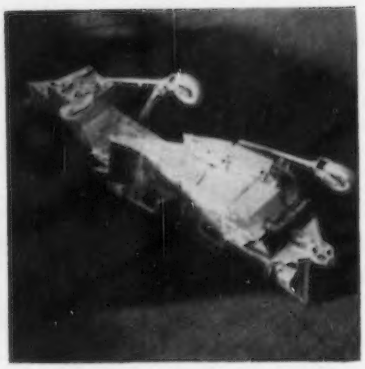
	Jumbo I (8 RH-656-2L)		Jumbo II (4 BBC 41RB)	
	Actual work at Gulsele	Estimated work in normal rock	Actual work at Gulsele	Estimated work in normal rock
Drilling rate, in per/min	6 11/16	11 13/16	14 15/16	23 5/8
Drillers in crew	3	3**	2	2
Footage drilled				
Jumbo, ft per/hr	115	187	88.5	124.5
Rock drill, ft per/hr	14.4	23.3	22.3	31.2
Drillers, ft per/hr	42.6*	65.6**	46*	62.3*
Volume solid rock drilled				
Jumbo, cu ft per/hr	1660	2649	1978	2790
Rock drill, cu ft per$hr	208	335	494	688
Drillers cu ft per/hr	600	954**	1024	1413
Time Distribution				
Going to and from work	5%	5%	5%	5%
Moving Jumbo	4	6	6	8
Collaring holes and preliminary work	13	19	9	13
Drilling through muck	4	5	7	8
Adjustment and supervision of feed	12 } 40	15 } 33	9 } 32	10 } 28
Observation only	24	13	16	10
Changing drill steels and bringing up drills	8	13	16	21
Stuck drill steels	17	6	17	5
Pauses, waiting time	13	18	15	20
	100%	100%	100%	100%

*Besides operating drills, drillers also help with some mucking.

**If Jumbo can be operated by two drillers in normal rock, estimated capacity per driller would be further increased by 25%.

this should be taken into consideration.

Tunnel has cross section of approximately 1,670 sq ft. Top heading was approximately 1,184 sq ft, and bench was approximately 485 sq ft. Width was 35 ft and height of bench 14 ft. Two different types of jumbos were used for drilling, one equipped with light air flush machines and the other with heavy water flush machines.



Phosphate Planer Tested in Montana

FEASIBILITY and applicability of phosphate rock planer are proven by results of tests made jointly by U. S. Bureau of Mines and Montana Phosphate Products Co. at latter's Anderson mine near Garrison.

Machine, under development intermittently since April 1954, is patterned after pneumatic vibrating-blade planer developed in Germany during WW II for continuous mining of flat coal beds. Welded steel body rolls along footwall (floor) on pair of pneumatic-tired wheels under each end. These can be angled to crowd machine toward face as it is winched along by wire rope and hoist. Blades at each end plow floor clean. For steeper beds, two similar wheels, mounted caster-like on booms, are pressed against hangingwall (roof) to add to weight component on floor wheels.

Vertical bank of four 80-lb pneumatic paving breakers, in wedge-shaped housing, continuously chip out rock. Lowest cuts floor line. Fifth, on top of housing, is hinged at rear and supported near front by air leg. Height is adjusted to cut roof line. It trails main breakers a little and breaks down brow. Broken rock falls into inclined trough-like center well and is plowed up and away from face.

Although no sustained production runs have yet been made, this prototype, made of second-hand material and modified a number of times, works well. Several features desirable in production machine were omitted for economy. According to Thomas E. Howard, principal USBM developer, considerable credit for progress is due to fine cooperation of F. E. Burnett and staff at Anderson mine. USBM paper on machine is awaiting publication in Washington.

MINE PACKING

Guards rods against grit-filled water

U. S. CENTRIFUGAL PUMP PACKING (STYLE NO. 196) for handling hot or cold, fresh or salt water (pumped from mine) filled with harmful grit. This grit cannot get into the packing and score the rods. A high-tensile brass wire is inserted in the yarn to prevent the grit from tearing the yarn and getting through to score the rods. Also fine for handling oil and ammonia.

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Mechanical Goods Division

United States Rubber

NEW BOOKS

Mineral Facts and Problems, Bulletin 556, by the staff of the U. S. Bureau of Mines. Volume contains commodity studies on nearly all the metals and minerals as compiled by the Bureau's commodity analysts. As part of its work, the Bureau has surveyed the origin, occurrence, reserves, beneficiation, refining, use and major problems of the commodities.

Studies are listed by author, many of which are familiar to *E&MJ* readers for their articles in *E&MJ'S* February Annual Review.

Individual copies of the separate chapters are still available upon request to the Superintendent of Documents. These chapters can be had by writing to the Superintendent, giving the name and author of the chapter as from *Bulletin 556*. Price per chapter is nominal—5 to 10c.

Or you may obtain the entire bound volume by addressing your request for *Bulletin 556* to the Superintendent of Documents, Washington 25, D. C. 1008 pp. Price $5.75.

Chapters From Bulletin 556

Aluminum and bauxite, by D. D. Blue.
Anthracite, by J. W. Buck and J. A. Corgan.
Antimony, *Arsenic* and *Bismuth*, all by Abbott Renick
Tin, by A. Renick and J. B. Umhan.
Asbestos, and *Stone*, by O. Bowles.
Lime, by O. Bowles and J. Arundale.
Sand and gravel, by J. Thoenan and O. Bowles.
Barium, *Boron*, *Iodine*, *Lithium*, *Salt*, *Sodium* and *Strontium*, all by J. C. Arundale.
Beryllium, *Columbium and tantalum*, *Zirconium and hafnium*, by H. T. Reno.
Cadmium, by R. L. Mentch.
Lead, and Zinc, by O. M. Bishop and R. L. Mentch.
Cement, *Gypsum*, *Perlite*, and *Vermiculite*, by O. S. North.
Cesium, *Gallium*, *Germanium*, *Indium*, *Rhenium*, *Rubidium*, *Scandium*, *Selenium*, *Tellurium*, *and Thallium*, all by J. D. Sargent.
Chromium, by C. Katlin.
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Copper, and *Mercury*, by Helena M. Meyers.
Corundum, *Diamond*, *Diatomite*, *Garnet*, and *Pumice*, all by H. P. Chandler.
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Fluorine, by J. E. Holtzinger.
Gemstones, and *Jewel-bearings*, by R. D. Thomson.
Mica, by W. F. Dietrick and R. D. Thomson.
Gold, *Platinum-group metals*, and *Silver*, by J. E. Bell.
Rare earths, by F. Lamb.
Graphite, by F. Lamb and D. Irving.
Talc, by D. R. Irving.
Helium, by H. P. Wheeler, Jr.
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Manganese, by G. L. DeHuff, Jr.
Minerals research, by S. Gottley.
Nitrogen, *Phosphate*, and *Potash*, by E. R. Ruhlman.
Oil-shale, by S. Klosky.
Petroleum and natural gas, by R. A. Cattell and others.
Quartz, by W. F. Dietrick.
Radium, *Thorium*, and *Uranium*, by J. E. Crawford.
Steel, by J. C. O. Harris.
Sulphur, by G. W. Josephson.
Titanium, by F. J. Cservenyak and A. F. Tumin.
Bituminous coal, and *Lignite*, by Solid Fuels staff.
Index, by Mabel E. Winslow.

Engineering & Mining Journal 1956 Mining Guidebook (reprint), by the editorial staff of *E&MJ*. Reprint of the editorial section is available from the Reprint Editor. The *1956 Mining Guidebook* covers exploration, open-pit and underground mining, milling and metallurgy, with particular reference to the kinds of equipment available to do the job in each department.

A valuable handbook and useful tool for mine and mill man. Published and reprinted by *Engineering & Mining Journal*, McGraw-Hill Publishing Co., 330 W. 42nd St., New York 36, N. Y. Photos, check-charts, tables, sketches and text in 128 pp. Price $1.

Elementary Geochemical Prospecting Methods, by L. M. Anthony, assistant professor University of Alaska. Booklet can be obtained by addressing request for same to the University of Alaska, College, Alaska.

Foundations, Design and Practice, by E. E. Seelye. Nineteen chapters covering the subject with plenty of sketches, tables and details of the problems. Published by John Wiley & Sons, Inc., 440 4th Avenue, New York 16, N. Y. Price $16.

Manual of Excellent Management, 1956, by the American Institute of Management. This book explains their rating system and lists (in their opinion) the top managed companies in the U. S. and Canada. It included a full-scale Management audit of the Aluminum Company of America. Free to members of the Institute, otherwise $20. 177 pp.

Circular 214, Geologic Structure Map of the Northwestern Illinois Zinc-Lead District, by J. C. Bradbury, R. M. Grogan and R. J. Cronk. Published by the Illinois State Geological Survey, Urbana, Ill. Map and 7 pp.

Lead Deposits of the Upper Cambrian of Central Texas, by Virgil E. Barnes. Published by Bureau of Economic Geology, University of Texas, Austin 12. Text and tables in 68 pp. Price $1.

Report of the Geological Survey Department for the Year 1954. Published by British Guiana Geological Survey. Printed by the Daily Chronicle, 23 and 24 Main St., Demerara. Maps and 105 pp. Price $1.

Bulletin No. 29, Geology of the Issineru-Enachu District, Mazaruni River, British Guiana, by E. R. Pollard. Published by British Guiana Geological Survey. Printed by the Daily Chronicle, 23 and 24 Main St. Demerara. Map and 63 pp. Price $1.

92-Million More Mouths to Feed, by Hunting Technical Services, Ltd. Pamphlet explains the purpose and function of land mass reconnaissance; soil classification; range, forestry, geological and geophysical, and groundwater surveys. Excellently well done in 16 pp, with overlay maps and plates. Free on request to Hunting Technical Services, Ltd., 4 Albemarle St., London, W1.

• Professional Papers and Bulletins from the U. S. Geological Survey (as listed below) may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Remittances should be made by money order.

Professional Paper 279, Cenezoic Geology of the Colorado Plateau, by Charles B. Hunt. Maps, sketches and text in 96 pp. Price 75c.

Professional Paper 276, Stratigraphic Section in the Vicinity of Eureka, Nevada, by T. B. Nolan, C. W. Merriam and J. S. Williams. Maps and text in 71 pp. Price $1.

Professional Paper 277, Stratiography of the Mascot-Jefferson City Zinc District, Tennessee, by Josiah Bridge. Maps and text in 74 pp. Price $3.50.

REMINDER LIST
of maintenance steel products

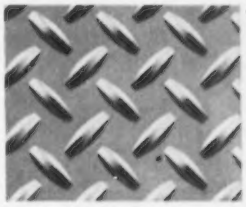
You can save time and trouble in the weeks ahead if you will take a minute now to review your coming requirements for maintenance steel products—those you will want for summer shut-down work as well as your more immediate needs.

All the products listed below are in good supply at Ryerson right now, and, of course, we have many other maintenance products ready for quick shipment as well—boiler tubes, chain and accessories, tool steel, etc.

When you combine all maintenance steel requirements on one order you may save more than purchasing time. Freight costs may be lower, and prices, too, under the Ryerson quantity differential plan.

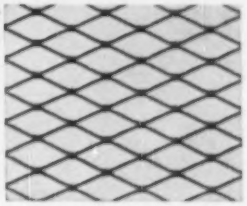
Perhaps this list will suggest ways to plan ahead and save

COLD FINISHED SHAFTING—Ryerson stocks of turned, ground and polished bars (C-1025, C-1045 and C-1141) provide a ready source for shafting of outstanding size accuracy, straightness and concentricity. For greater strength draw on Ryerson stocks of heat treated Rycrome—a medium carbon alloy.



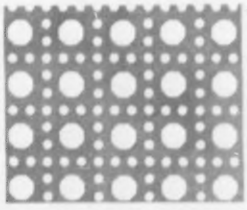
SAFETY PLATE—Tough, rolled steel plate with the Inland 4-WAY safety pattern is available in two pattern sizes for industrial flooring, stairs, ramps, platforms, etc. Firesafe, long wearing, easy to clean, it provides good traction for feet or wheels and presents an attractive appearance. Easy to fabricate and install.

EXPANDED METAL—Furnished in two basic types, standard and flattened, Ryex expanded metal is light yet strong and rigid—easy to handle because all sharp edges have been removed. Use it for room enclosures, machine guards, grilles, shelves, bins, etc. Also available: Ryex expanded metal grating.



WELDED GRATING for strong, rigid and durable open steel flooring is available from Ryerson in stock size panels and sizes tailor-made for your job with all necessary cut-outs and banding. Easily installed and maintained, Ryerson welded grating can be furnished painted or galvanized. Send for engineering data.

STAINLESS PIPE & TUBING and fittings as well, are on hand in a complete range of types—304, 316 and 304-L for welding applications involving severe corrosion, and in a comprehensive range of sizes including schedules 5, 10, 40 and 80 pipe sizes. Valves and welding and screwed type fittings also available.



PERFORATED SHEETS are on hand for immediate shipment in standard cane and machine guard patterns. And you can also get quick service on a wide variety of other patterns perforated to order from large Ryerson stocks of carbon steel and stainless sheets and plates. Send for descriptive literature.

GALVANIZED SHEETS—Tight-coated galvanized that forms without flaking is available in a wide range of gauges and sizes. Sheets take paint or lacquer readily without "weathering." And for roofing, siding, etc. they can be furnished with standard corrugation or with the attractive new mansard corrugation.

GLYCO BABBITT METAL AND RYERTEX BEARINGS—Glyco Babbitt, produced in our own foundry from top quality virgin metals, is available in five grades to meet every babbitt bearing requirement. Ryertex plastic bearings which need only water lubrication can also be furnished promptly—in any size or shape.

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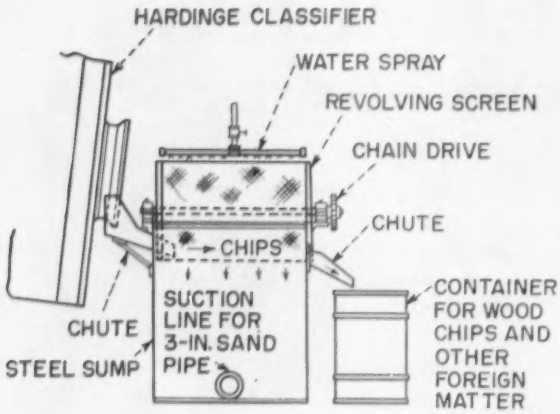
OPERATING IDEAS

Lloyd E. Antonides



Screen Traps Light Material

WOOD CHIPS and other light foreign matter in classifier overflow can give pump trouble and increased pump wear. Occasionally, concentrates received at Salt Lake Tungsten Co., Salt Lake City, Utah, contain such material. Prior to present setup, overflow from classifier in regrind circuit of materials preparation department, was pumped directly to chemical upgrading plant by sand pump. Now a revolving screen removes foreign matter ahead of pump sump. Arrangement designed by I. W. Wingo, plant foreman, consists of cubical steel-plate sump on top of which is trommel screen driven by small chain-reduction geardrive. Water spray permits periodic cleaning of bolted-on screen sections. Overflow enters screen, undersize falling to sump and foreign matter passing to waste container. Sump and screen are of scrap material.

Gage Checks Lubrication

PRESSURE GAGE permanently mounted on end of rotating shaft of spiral (screw) classifier makes checking for lubrication quick, easy and positive. Installation at Barvue Mines Ltd., Barraute, P.Q., is shown. M. D. Isbister, mine manager, says idea originated at Golden Manitou Mines Ltd., Val d'Or, P.Q. Lube fitting on end of Akins classifier shaft was removed and hole retapped so ½-in. pipe nipple could be inserted. Onto nipple a ½-in. pipe "T" was screwed so that lube fitting could be screwed back into axial arm and Peacock diaphragm pressure (0-100 lb) gage could be fitted into radial arm. When grease gets low, pressure drops and gage indicates need for more. Only then is grease gun used. Normally, only way to check if lubrication is adequate, is to use grease gun and pump until full pressure is reached or until lubricant shows at end of bearing. Of course, since classifier turns at only 3-6 rpm, it need not be stopped at any time.

NOW, mostly steam escapes in contrast to dust from stack when collector is by-passed.

NOZZLE holders are plastic.

Wooden Collector Works Best

WHEN CYCLONES and concrete-lined water-spray units failed, a wooden wet collector solved the problem of hot, abrasive-corrosive stack dust for Southern Lightweight Aggregate Corp. According to Harry E. Seifert, director of process engineering for the Richmond, Va., firm, the patented set-up is economical to build and needs little maintenance. He says company will furnish drawings and engineering service for nominal fee.

After other commercial devices failed in six weeks' time, the company designed first of two baffled water-spray chambers shown above. It handles effluent from six rotary kilns. Second unit, built later, is stand-by.

Wood pegs hold Waltman Salts-treated fir plank together on poured concrete slab. Floor slopes to center drain. Each of two fans exhaust from three kilns and blow into end of 15 x 15 x 50-ft structure. As effluent follows zig-zag path to outlet, it is subjected to fog from nozzles on top and fan-shaped spray from nozzles on sides. Dust laden water falls to floor and out drain into settling pond before entering stream one mile away.

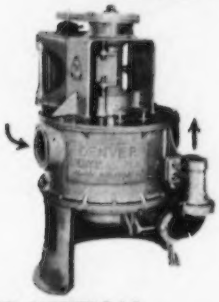
Abraded fan blades are replaced every eight months and corrosion and erosion of floor at inlet shows need for repair after about 18 months. Although nozzles did not corrode, holders did until plastic pipe was used.

(*Operating Ideas continue on p 112*)

DENVER CAN SUPPLY COMPLETE EQUIPMENT FOR YOUR MILL

One Responsibility

Crushers, Screens, Feeders, Ball-Rod Mills, Classifiers, Jigs, Pumps, Samplers, Agitators, Conditioners, Flotation, Thickeners, Filters, Dryers, Ore Testing and Mill Design Services.

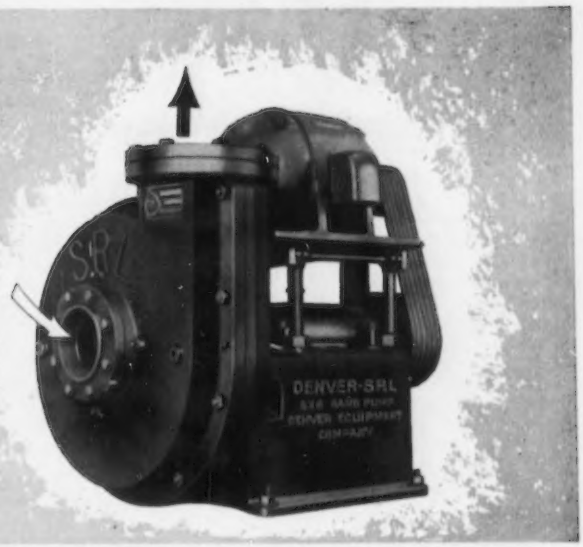


DENVER VERTICAL CENTRIFUGAL SAND PUMP . . . for use where

1. Feed is intermittent.
2. Pulp is frothy or air laden.
3. Feed varies in density.
4. Floor space is limited.
5. Plant portability is an advantage.
6. Long life is a factor.
7. Initial cost must be minimum.
8. Feed sump is impractical.

Sizes from ¾" to 4". Also Denver Adjustable Stroke Diaphragm Pumps from 2" to 8", simplex and multiple units.

For complete information, WRITE FOR BULLETIN NO. P10-B5.



How DENVER SRL (Soft Rubber Lined) PUMPS CAN CUT YOUR PUMPING COSTS...for abrasive pulps or tailings

1. POWER COSTS CUT

Denver SRL Pumps often use less than one-half the brake horsepower required by other pumps in similar service. This is the result of simplified design and high efficiency of molded rubber parts. **This means substantial savings for you in power costs and maintenance.**

2. SHUTDOWN TIME REDUCED

Because molded rubber parts are highly resistant to corrosion and abrasion, case history records show where Denver SRL parts lasted up to 15 times longer than parts on pumps previously on the same service. This means increased production, savings for you in maintenance costs—and, more important, reduced down time.

3. A PUMP FOR EVERY JOB

Denver SRL Rubber Lined Pumps are available to you for standard or heavy duty service and with capacities up to 2400 g.p.m. You can choose exactly the right pump that will do your pumping job most efficiently, most economically. Parts for all sizes are kept in stock for fast service.

If you have abrasive or corrosive material to pump, you can make substantial savings by using Denver SRL Rubber Lined Pumps. For complete information about what Denver SRL pumps can do for you, **WRITE TODAY FOR FREE BULLETIN P9-B8. MOST SIZES OF SRL PUMPS IN DENVER STOCK.**

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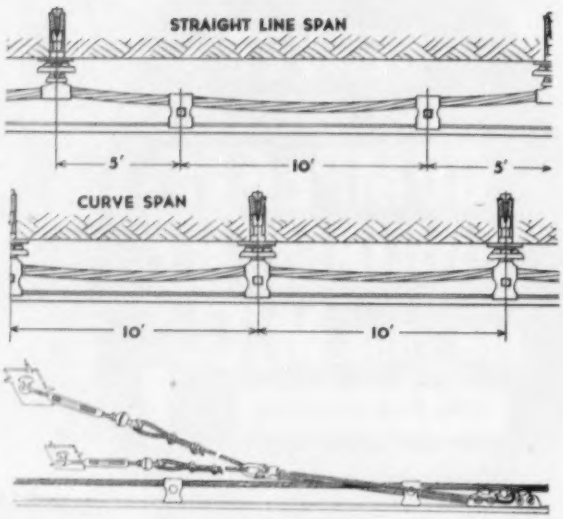
Cushioned Trolley Helps

COMPARED TO INDEPENDENT SUSPENSION for feeder cable and trolley wire, "cushioned trolley" takes up less space, needs fewer hangers and holes in roof, and—because it eliminates all hard spots or rigid connections between wire and roof—it results in smoother collection and much less wear on both trolley wire and collection equipment.

As shown in top sketch, feeder cable is held in Ohio Brass Feeder Slings attached to standard O-B Hanger. Trolley wire is suspended directly from cable with O-B Combination Feeder-Trolley Clamps. To keep hard spots out of trolley wire, Combination Clamps are spaced at quarter span points each side of Feeder Slings. Slings are equally spaced and tension in each feeder span is kept uniform. Thus sag at each clamp is same and trolley wire is easy to keep at on level.

On curves a different construction is used, middle sketch.

Setup shown in lowest sketch permits tensioning trolley wire without interfering with feeder and trolley lines. Assembly can be left in place as permanent fixture (on curves, for example) or moved ahead after clamps are tightened. All accessories are available from Ohio Brass Co., Mansfield, Ohio, who also supplied information used in this "Op Idea."



Loader Helps Place Stemming

BRINGING STEMMING material right to hole in spite of slick drill sludge is easy job for tractor-loader at this copper pit in Arizona. While bench clean up is main job for the 2¼-yd Michigan, trucks often have trouble in sludge spill so large-wheeled tractor unit was successfully adopted and proved even more convenient.

Loader also moves sand, aggregate and cement around concrete mixing plant and, being wheeled, can quickly "commute" to work at new pit 2 miles away.

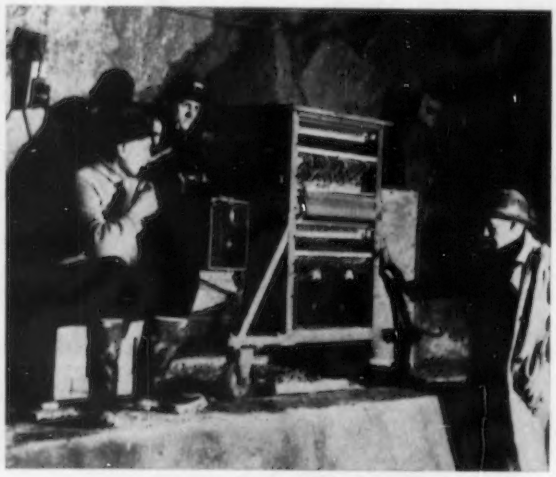
Counter Gages Tunnel Overburden

THICK OVERBURDEN (about 500 ft) and rugged terrain indicated drilling would be a costly way to measure rock over the Guthega-Munyang tunnel in Australia. Although in this case mass of overburden was needed to calculate upward pull on water in tunnel, similar problem may be faced in other underground work.

The alternative adopted by the Snowy Mountains Hydro-Electric Authority was to use cosmic radiation and a geiger counter—comparing intensity in open to that at selected points in tunnel. Principle is same as industrial thickness gages in which absorption of artificial radiation by a homogeneous substance is proportional to thickness (actually mass per unit area). But whereas radioactive disintegration rays are absorbed in a few feet of rock, cosmic rays have been detected at 3,000 ft underground.

The apparatus was devised by Dr. E. P. George, School of Physics, University of Sydney. Ruggedly constructed, it weighs about 120 lbs and used 100 counters. Power, 200 watts, came from tunnel mains.

Prof. J. D. T. Leech Scientific Services Division, Snowy Mountains H-E A, collaborated in the work. Dr. George believes method is faster and cheaper than drilling for depths over 50 ft. Of course, in contrast to drilling, no details on variation in density can be expected and there must be a pre-existing opening.



SHAHMOON INDUSTRIES OPERATES TWO KENNEDY SWING JAW CRUSHERS, ROCK FEEDERS AND CONVEYOR SYSTEMS

to crush and handle Iron ore

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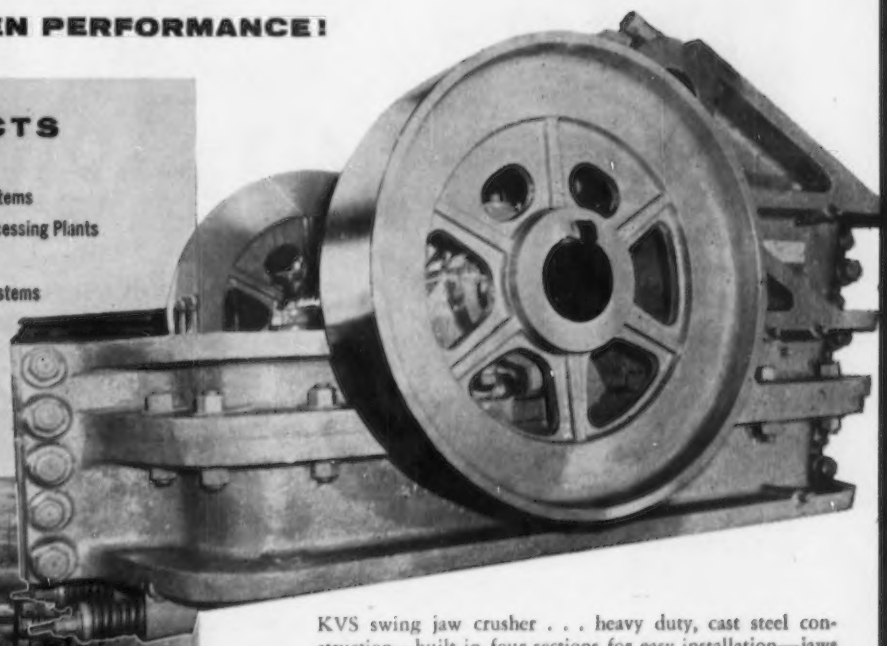
ON A BASIS OF PROVEN PERFORMANCE!

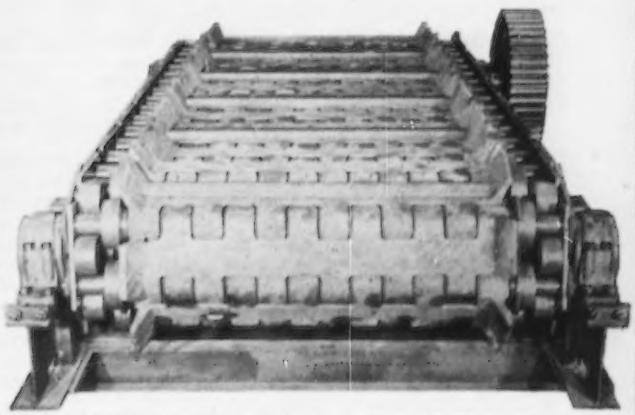
KENNEDY PRODUCTS

- Gyratory Crushers
- Swing Jaw Crushers
- Tube Mills
- Ball & Rod Mills
- Vibrating Screens
- Rock Feeders
- Air Swept Tube Mills
- Rotary Kilns
- Coolers, Dryers
- Preheaters, Deheaters
- Belts, Conveyors
- Pneumatic Transport Systems
- Complete Aggregate Processing Plants
- Waste Heat Boilers
- Pulverized Coal Firing Systems
- Asbestos Plants
- Complete Lime Plants
- Complete Cement Plants
- Steam Generators



KVS swing jaw crusher . . . heavy duty, cast steel construction—built in four sections for easy installation—jaws reversible, end to end for long wear.

Phillipsburg plant, Shahmoon Industries, showing direct loading to crusher house and KVS conveyor system.



KVS heavy duty rock feeders with overlapping pans.

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PERSONALS

Cominco Makes Three Executive Changes

W. S. Kirkpatrick, left, vice president and director of Consolidated Mining & Smelting Co. of Canada, Ltd., has been elected executive vice president of the company. **R. D. Perry,** center, general manager since 1952, has been named vice president. **R. W. Diamond,** right, executive vice president of the Western Region, has retired, but will remain with the company in an advisory capacity. Mr. Kirkpatrick joined the company in 1926 and was named a vice president in 1951. Mr. Perry joined Cominco in 1928. Mr. Diamond joined the company in 1917 and was named vice president and director in 1945.

Roger W. Straus, chairman of American Smelting & Refining Co., has been named to represent the primary metals industries on the National Advisory Council.

Bruce B. Whitney, former assistant mine superintendent at Inspiration Consolidated Copper Co., Miami, Ariz., has been appointed general superintendent of the company's operations at Christmas. **Thomas E. Bilson** will succeed Mr. Whitney as assistant mine superintendent.

Clarence B. Randall, chairman of Inland Steel Co. and subsidiaries, retired on April 1st. He has been succeeded by **Joseph L. Block,** president of Inland.

John B. Myers was elected president of the Zonolite Co., miner and processor of vermiculite, at a recent board of directors meeting. Formerly vice president in charge of mining and production, Mr. Myers succeeds **A. T. Kearney,** who continues as board chairman. **J. A. Kelley,** vice president of the southern division, has become executive vice president of mining and production, taking over duties formerly assigned to Mr. Myers.

John Q. Jones has been named research metallurgical engineer of Shattuck Denn Mining Corp.'s new development and research laboratory at Humboldt, Ariz. Mr. Jones has been associated with the AEC's Raw Materials Development Laboratory at Winchester, Mass. and Grand Junction, Colo. since 1951. **Alba W. Jeffers** has been named senior research metallurgical engineer. For several years Mr. Jeffers was technical representative for American Cyanamid Co.'s mineral dressing division.

Harold D. Vaughan has opened a consulting office for mining geology at Bakersfield, Calif. He formerly was with Anaconda Copper, Balfour-Guthrie, B & B Quicksilver, Western Empire Gold & Silver and Middle Buttes Mining Co.

Fred G. Michels, safety director for North Range Mining Co., was program chairman for the 1956 Lake Superior Mines Safety Council, held in Duluth May 17-18.

Melvin Viant, Hibbing, Minn., superintendent at the Agnew Mine for Cleveland Cliffs Iron Co., has been transferred to the Wanless Mine at Buhl. The Agnew mine is nearing the exhaustion stage.

Howard Wilmeth has been named mine engineer for Kennecott Copper Corp.'s Chino Mines Division, succeeding **W. W. Baltosser,** who has accepted an assignment with Bear Creek Mining Co., as exploration subsidiary of Kennecott. Mr. Wilmeth joined Kennecott in 1950.

Sheldon J. Dicks, mining engineer formerly with Pickands, Mather & Co., has joined Youngstown Sheet & Tube Co. in their raw materials department.

Arthur W. Fahrenwald, University of Idaho dean of mines emeritus, has been awarded the Richards Award for 1956, presented annually by the American Institute of Mining & Metallurgical Engineers for achievement in the minerals beneficiation field.

Robert C. James has been named head of the new exploration office of Cerro de Pasco Corp. located at 3656 E. Speedway, Tucson, Ariz.

James H. Bright has recently joined the Timber & Minerals Division of J. M. Huber Corp., as a mining geologist. Mr. Bright formerly had a consulting practice in Casper, Wyo.

Roger O. Oscarson, former secretary of the Northwest Mining Association, has been named area minerals officer for the Bureau of Land Management, with a territory including California, Oregon and Washington. His headquarters will be in Portland, Ore. A mining engineer, Mr. Oscarson left Spokane in 1952 to join BLM in Washington, D. C.

Charles Butler, of Cortez, and **Robert Simpson,** of Grand Junction, both uranium operators, have been appointed to the executive committee of the Colorado Mining Association.

Marvin Kay, general manager of the Climax Uranium Corp., Grand Junction, has been named chairman of the program and budget review committee of the new Uranium Institute of America. **Gordon Weller** is new administrative vice president of the institute.

Dr. D. R. Derry has been elected president and managing director of Rio Canadian Exploration, Ltd., succeeding **O. Weiss** who has resigned. Dr. Derry was formerly executive vice president. **J. A. Sadler,** former chief mining engineer for the Province of Manitoba, has been named assistant manager of the company succeeding **B. I. F. Beakey,** resigned.

Robert C. Pruess, Grand Junction, has been named to the board of directors

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Why two totally different blower types? Because the requirements of mine ventilation fall into two entirely different categories.

For high pressures, long pipe lines, use the Coppus VENT-AIR® (centrifugal type). For medium pressures, shorter pipe lines, the Coppus VANO® (propeller type) is best. One or the other will give you more air per given power consumption than other blowers — from 30% to 100% more. Can be used as blowers or exhausters, capacities up to 90,000 CFM, with compressed air or electric motor drive.

Only Coppus makes both types. And, for quick recognition, each wears the famous "Blue Ribbon", distinguishing mark of top-quality engineering, materials and performance. This blue band is your guarantee of better mine ventilation . . . Look for it.

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PERSONALS *(Continued)*

DR. W. A. MUDGE has been appointed special representative on educational programs of the International Nickel Co. of Canada, Ltd., and International Nickel Co., Inc., cooperating with universities and colleges in Canada, the United Kingdom and U. S. in dissemination of technical data and scholarships.

of Continental Uranium Corp. He had been general manager and director of mining operations since 1954.

Henry L. Pierson has been elected vice president and secretary of Freeport Sulphur Co. He joined Freeport as assistant secretary in 1939 and was elected secretary in 1947.

Paul Hunter has been named safety director for the Chino Mines Division of Kennecott Copper Corp. in Santa Rita and Hurley, N. M.

J. O. K. Kalliokoski has been named assistant professor of Geology at Princeton University beginning in September. He is currently associated with the Newmont Mining Co, in Arizona, and was formerly a member of the Canadian Geological Survey.

James H. McClain, chemical engineer with the U. S. Bureau of Mines for 14 years, has resigned to become plant manager for the zirconium production operation of Wah Chang Corp., at Albany, Ore.

John H. Nason has joined Colorado Oil & Gas Corp., Denver, and has been appointed vice president of its subsidiary, COG Minerals Corp., producer of uranium ore. He had been general manager of the plant food division of Olin Mathieson Chemical Corp. since 1954 and prior to that was executive vice president of Olin Mathieson beginning in 1949.

R. J. Horsman has resigned as chief engineer for Day Mines, Inc., after 14 years of service, to take a position on the exploration staff of the Bunker Hill Co. He has been succeeded by **Ray Giles,** who returns to the Day firm after 2 years with Wah Chang in Bishop, Calif.

Philip I. Conley, Wallace, Idaho, has been named chief geologist of American Smelting & Refining Co.'s northwestern mining department, succeeding **A. O. Hall,** resigned. Mr. Conley joined Asarco in 1946.

Marion D. VanDelinder, pit foreman at Oliver Iron Mining Division's Monroe mine, has been named assistant superintendent at that mine.

Edward Ziolowski has joined the Pickands, Mather & Co. organization as engineer at the Peterson mine near Bessemer, Gogebic Range.

Dr. Grover C. Dillman, president of Michigan College of Mining and Technology at Houghton, Michigan, since 1935, has announced his retirement as of October 1.

Dr. Joseph T. Benedict has joined the staff of the Bayonne Research Laboratory of International Nickel Co., Inc., as a member of the Electrochemical Section. Dr. Benedict entered the Graduate School at Massachusetts Institute of Technology in 1946, and in 1950 received his Doctorate in Inorganic Chemistry after successfully separating zirconium from hafnium by the use of ion exchange resins.

Douglas D. Donald has recently joined the staff of Behre Dolbear & Co., Inc., mining, geological and metallurgical consultants in New York. A graduate of the Columbia School of Mines, he has been employed for the last 5 years by the New Jersey Zinc Co. at Austinville, Va.

Frederick A. McGonigle, vice president in charge of operations of Haile Mines Inc., was awarded the professional degree of Engineer of Mines from Montana School of Mines, June 8. Professional degree of Geological Engineer was awarded to **Walter R. Landwehr,** chief geologist of the Western Mining Department of American Smelting & Refining Co.

Bruce A. Gould, consulting mining engineer, has just returned from a four month business trip to England, Portugal and South Africa.

R. L. McCann, president of New Jersey Zinc Co. was the recipient of the 16th annual L-in-Life award presented by the Lehigh University Club of New York.

Distinguished achievement medals were awarded Colorado School of Mines alumni at commencement exercises in May. Receiving medals were **Arthur C. Daman,** president of Denver Equipment Co.; **Russell H. Volk,** president of Plains Exploration Co.; **Franklin Coolbaugh,** vice president of Climax Molybdenum Co.; and **Phillip J. McGuire,** director of filtration product development for the Dorr-Oliver Co.

CECIL A. FITCH JR. has been appointed president and general manager of the Chief Consolidated Mining Co. of Eureka, Utah, succeeding **Cecil A. Fitch,** who resigned but will remain with the company in a consulting capacity. Mr. Fitch Jr. had been vice president and general manager.

Leonard L. Hank, formerly general production manager, has been elected vice president of manufacturing, in charge of all the company's 37 plants and its mines and quarries, for National Gypsum Co. **Lewis B. Crowell,** production manager for the firm's coastal gypsum division, was named general production manager, and will be succeeded by **Robert E. Scifres,** now manager of National Gypsum's Shoals, Ind. plant.

Forbes K. Wilson has been elected assistant vice president of Freeport Sulphur Co. Joining Freeport in 1942 as a mining engineer, Mr. Wilson is manager of mineral exploration of Freeport. He is also vice president of Nicaro Nickel Co., a wholly owned subsidiary.

Ernest G. Enck has been named director of Planning. **William M. Raynor** has been named director of purchases, and **Walter J. Brooking,** former general purchasing agent, has been promoted to assistant director of purchases for Foote Mineral Co.

Cerro de Pasco Corp. has named four Peruvians to post-graduate one-year scholarships in the U. S. in a program designed to encourage advanced scientific and technical studies by the corporation's Peruvian technicians. **Marcial Garcia y Garcia, Hernando Arauco Fajardo, Julio Flores,** and **Adan Martinez Aguirre** were named as recipients of the awards for the 1956-57 academic year. The four will first undergo an intensive orientation course for foreign students at the Colorado School of Mines at Golden. Sr. Arauco will enroll in a graduate course for metallurgists at the Montana School of Mines, while the remaining award

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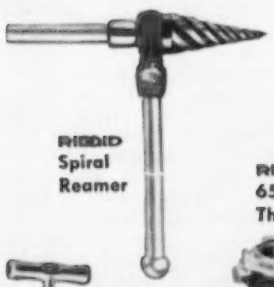

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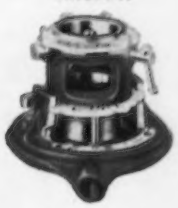

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You can't beat it for performance, easy work and durability. Buy it at your Supply House . . . much the most for your money!

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PERSONALS *(Continued)*

FRANK ARKO, a miner employed at Noranda Mine, Noranda, Que., has been awarded a gold medal by the Canadian Institute of Mining and Metallurgy for bravery in saving the life of one of his co-workers.

winners will study at the Colorado School of Mines.

Glen S. Locker, general claims agent of the Northwest division of U. S. Steel Corp., has retired after 41 years of service.

William N. Matheson Jr., has been named vice president of operations for Oliver Iron Mining Div., U. S. Steel Corp. Mr. Matheson, associated with Oliver since 1933, is a graduate of Minnesota School of Mines with a degree of Engineer of Mines, and has been actively engaged as an operator and supervisor in charge of Oliver operations.

William H. Goodrich, general manager of the Chino Mines Division of Kennecott Copper Corp., was awarded an honorary degree of Doctor of Laws by New Mexico A&M College, June 3.

Edward J. Oosthuizen has joined South African Cyanamid (Pty.) Ltd., as a sales engineer in the mineral dressing department. He was recently associated with Buffelsfontein Gold Mining Co., Ltd., as reduction manager, and prior to that was with Stilfontein Gold Mining Co., Ltd., in the same capacity.

H. E. Bakken, general manager of the refining division; **J. P. Haight,** chief engineer; **Lawrence Litchfield Jr.,** general manager of the mining division; **R. T. Whitzel,** general production manager; and **Edward B. Wilber,** treasurer, have been named vice presidents of Aluminum Co. of America.

H. E. Doelle, managing director of Sheep Creek Gold Mines Ltd., has been re-elected president of the Chamber of Mines, Eastern British Columbia. **G. A. Gordon,** general manager of Canadian Exploration Ltd., was elected first vice president, and **J. B. Shannon,** manager of Reeves MacDonald Mines Ltd., second vice president.

Albert P. Gagnebin has been named manager, and **Harold Larsen,** assistant manager, of nickel sales department of International Nickel Co., Inc. Mr. Gagnebin succeeds **Ransom Cooper Jr.,** who is retiring after 33 years of service.

R. D. Longyear, president, and **Eugene Larson,** sales manager of E. J. Longyear Co., are presently in Europe to attend trade fairs at Milan, Italy; Hannover, Germany and Birmingham, England.

John B. Henry, Jr., has been named product manager of high temperature metals and valve steels, and **George C. Kiefer** as manager of application development for Allegheny Ludlum Steel Corp.

William E. Cotter Jr. has been named assistant to the vice president-sales and planning, Oliver Iron Mining Division. He is succeeded as assistant purchasing agent by **Leonard L. Slabodnik.**

Robert Lyons, general pit foreman, Scranton Iron Mine operated by Pickands-Mather & Co., has retired.

H. Safford Nye, former treasurer for Richfield Oil Corp., has joined Cyprus Mines Corp. as a vice president and treasurer.

Harold R. Kirkemo, of the USGS staff at Grand Junction, is new chairman of the Colorado Plateau Section, AIME, succeeding **E. M. Paris.** Other officers are **Robert H. Sayre,** Grand Junction, first vice chairman, **B. S. Richards,** second vice chairman, and **R. L. Philippone,** secretary-treasurer. Directors are **A. G. Setter, Arthur W. Unger, Page Edwards** and Mr. Paris.

DR. RUSSELL C. BUEHL, formerly chief of the Bureau of Mines Pyrometallurgy Laboratories in Pittsburgh, has joined the staff of Rem-Cru Titanium, Inc., to study and develop new melting techniques for titanium alloys.

Richard F. Dooley, director of United Asbestos Corp. Ltd., the Admiral Corp., and Quebec Chibougamau Goldfields, Ltd., has been named to the board of directors of Bethlehem Copper Corp., Ltd.

H. W. Poole has been named superintendent of the Sullivan concentrator at Kimberley for Consolidated Mining & Smelting Co. of Canada. He succeeds **A. G. Robertson,** superintendent of concentration.

Charles J. Kundert has left the California Division of Mines to join Utah Construction Co., San Francisco, as geologist.

Obituaries

Edwin W. Mills, 79, veteran Arizona mining engineer and president of the Arizona Small Mine Operators Association, died June 5 at Wickenburg. He had served since 1947 as a member of the board of governors of the state department of mineral resources.

Platt Rogers, 71, native Coloradoan and prominent mining and construction official, died May 18 at his Colorado Springs home.

Harvey B. Mann, founder of Mann Engineering Co., died May 19 at Pittsburgh, Pa. A graduate of Cornell University with a degree in mechanical engineering, he was a member of ASME and the Engineering Society of Western Pennsylvania.

James Lawrence Head, 61, engineer with the Anaconda Copper Mining Co., died recently. A graduate of the Missouri School of Mines and Metallurgy, he was employed as a mining engineer by several Western firms before joining Anaconda in 1947.

Salo Katzman, 52, a vice president of Associated Metals & Minerals Corp., died May 17 after a brief illness. He was elected treasurer in 1944 and a vice president in 1954. Mr. Katzman was a member of the Advisory Group for metal scrap of the Department of Commerce in Washington.

Robert W. Buzzard, 52, project leader in the Metallurgy Division of the National Bureau of Standards, died of a heart attack while attending a conference of the Atomic Energy Commission at Ames, Iowa, on May 3. He was a member of the AIME and the American Society for Metals.

Archibald Benson, 69, widely-known in western Canada's mining industry, died May 4 at his home in Edmonton, Alberta. Mr. Benson for many years was manager of the Lakeside Mine at Wabamum, Alta., and retired in 1949.

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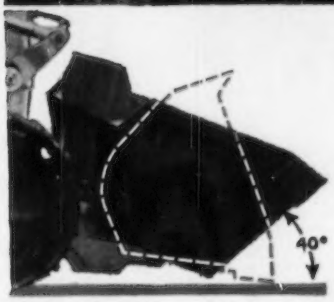

Tremendous pry-out force is obtained by using breakout pads on ground as fulcrum for leverage. Load forces transfer to ground instead of to machine.

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THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

A Threat to Economic Progress

THERE are two paramount reasons for concern over the serious shortage of scientists and engineers that now confronts the United States:

- The first reason, with which this editorial deals, is that continued expansion of our economy and further increases in our living standards are threatened unless we train more scientists and engineers and use them more effectively.
- The second reason for concern is that we run the risk of falling behind the Soviet Union in the technology so essential to national security. The consequences of losing this race to the Russians are not comforting. (The possibility that this might happen over the next few years was discussed in an earlier editorial in this series.)

The crucial contribution of scientists and engineers to the well-being of the American people has been to find ways of making better use of limited resources, to make equipment more productive, to develop new and better products that enrich our lives, to enable us to live longer and be healthier. They have made this contribution with greater success in the last 15 years than ever before, but it has required progressively more resources and more trained people.

During this 15-year period our annual production of goods and services, in dollars of constant purchasing power, has almost doubled. Since our total population has increased only 25 percent, this has meant a tremendous rise in the economic well-being of the American people as a whole. But in accomplishing this, the number of scientists and engineers has been more than doubled.

Tasks for Research

If the American economy is to continue to grow and if our living standards are to show further improvement, the work of scientists and engineers must be stepped up even more in the years ahead. Unless answers to several pressing problems are found through intensified research efforts, economic progress will become increasingly more difficult.

Productivity per hour of labor must be increased at a faster rate. Improved medical care has greatly increased the number of people who attain retirement age, and sharply higher birth rates since the war will mean larger numbers of children in school and college. Meantime, because of low birth rates during the depression, the number of people reaching working age is not rising nearly so fast. The result is that over the next 20 years our population will increase by about one-third, while the total manhours worked are not expected to increase more than 15 percent. So, simply to maintain the same living standards for a rising population — with no provision for additional improvements — ways must be found to enable each worker to produce for more dependents.

It is primarily to the scientists and engineers that we must look for help in making human labor more productive. This will require enormous increases in our power

resources. We will need to make more effective use of our existing fuel supplies — coal, oil and natural gas. And we will have to devise economically practical means of tapping other energy sources, particularly nuclear power and new rocket fuels.

Also, better ways must be found to use scarce and low-grade raw materials. Thanks to great strides in metallurgy and mining techniques, we are now utilizing sources of copper and iron ore that, for all practical purposes, were not available to us only ten years ago. Similar strides are needed in the mining and processing of bauxite if low-grade domestic ores are to help satisfy a fast-growing market for aluminum. And stubborn technical obstacles in the area of "high temperature" metals—such as nickel, cobalt, columbium, tantalum and titanium — are impeding progress in jet and turbine engines.

These are only a few of the challenging tasks that demand intensified research and engineering activity in the years immediately ahead if the United States is to continue to raise living standards. We need more houses, schools and highways for a rising population, more medical research to reduce further the ravages of illness, more research in chemistry and other sciences to sustain the flow of new and improved products that are so essential an ingredient of our economic progress.

Ceiling on Growth

American industry has indicated that it is ready to meet the challenge and undertake vastly expanded research programs. A recent survey conducted by the McGraw-Hill Department of Economics revealed that total research and development expenditures of American industry were almost $5 billion last year, 29% higher than in 1953. By 1959 business plans to be spending well over $6 billion on research and development. And the total could well prove to be much higher, based on the trend of recent years.

But industry's programs for research and development cannot be carried out unless enough qualified research workers and engineers are available. Ernest R. Breech, chairman of the Ford Motor Company, recently described the supply of engineers as the "ceiling on our future growth." He gave force to his point by announcing: "If 900 qualified engineers were to approach us next week looking for jobs, we would hire every one." The U. S. Bureau of Labor Statistics found in interviews with some 200 large companies at the end of 1954 — a recession year — that at least half were unable to hire enough research scientists and engineers to meet their needs. A third of the companies reported substantial shortages of technical personnel.

The shortage of technically trained people, furthermore, is becoming more acute. The number of engineers and scientists now being graduated is only about enough to cover replacement requirements, while the needs of industry, government and education are mounting every year. According to the best information available — as indicated in the first editorial in this series — these needs are now about twice as great as our current engineering graduating classes and annual production of scientists with Ph. D. degrees.

To perform the research needed to remove roadblocks to our economic progress — and at the same time hold our own in the technology essential to our security as a free nation — we must have an adequate supply of men and women with engineering and scientific training. Instead, we are faced with an acute shortage, now and for several years to come. Reasons for the shortage and proposals for working our way out of the shortage will be discussed in the remaining two editorials in this series.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

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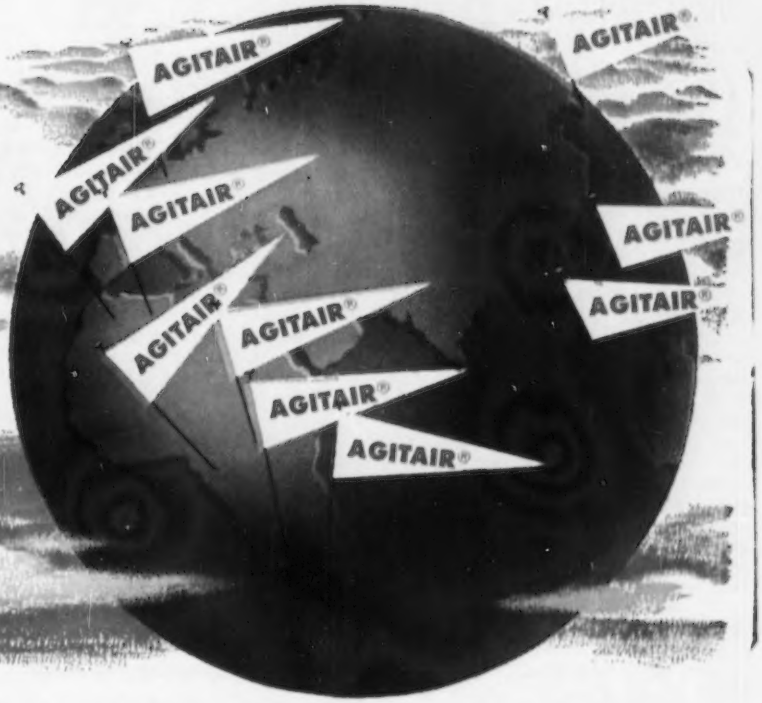

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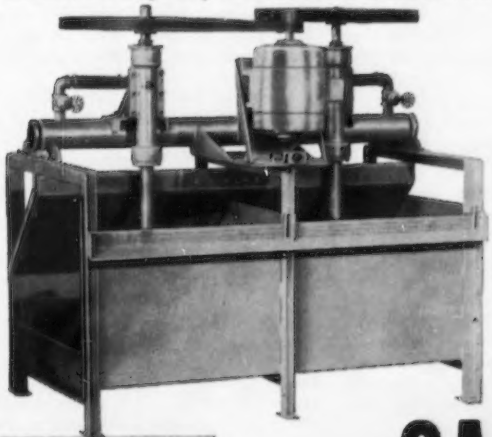

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WASHINGTON IMPACT

U.S. Barters for Lead, Zinc

BARTER WILL CONTINUE to be used for "substantial" stockpile acquisitions for some time to come according to Administration spokesmen.

Take the lead and zinc negotiations arranged by Agriculture late last month. As a case in point, they show how delicate is the situation between domestic producers and Government policymakers.

Under a new barter provision in the recently signed farm bill, Agriculture is bartering for upwards of 50,000 tons of lead and zinc. Contracts already signed, though classified "secret," call for short term delivery of part of this amount by the end of this calendar year. The materials have to come from friendly countries—largely from Europe and, in the case of zinc, Australia. The foreign shipper of ores or processed metals pays for transportation to stockpiling depots, plus duty where required. The price in some cases was equal to the U. S. price.

U. S. producers of lead and zinc have been assured of Government purchase support via defense stockpiling for several years, of considerable help in meeting market competition from lower-priced foreign ores. The Administration, on the other hand, is faced with disposing of vast agricultural surpluses, and also wants to get all the low-cost minerals it can without upsetting U. S. production too much.

Repeatedly, Government officials have given industry two assurances—(1) that barter negotiations won't in any way affect General Services Administration's announced policy of buying-American wherever possible, and (2) that materials acquired by barter will be placed in a so-called supplemental stockpile, which cannot be released on the open market without specific Congressional authorization.

More important, in Agriculture Department's view, is the beneficial effect it thinks barter arrangements will have on the world market. By drawing off world surpluses—such as exist in lead and zinc—the deals will help to hold up the world market price and thus at least indirectly help domestic producers.

On top of the barter deals came hearings before the Senate Foreign Relations Committee last month on legislation to set up world reserves of food and materials. On this subject Interior Department Assistant Secretary for Minerals Felix Wormser joined wholeheartedly with the American Mining Congress in voicing opposition to any such internationally controlled buffer stockpile. Designed to provide markets for over-produced countries and supplies for needy nations, a world reserve for minerals would actually encourage overproduction of marginal and sub-marginal ores, said Wormser. Also, AMC raised a number of questions as to how such an international program could be administered between cold-warring nations.

This proposal, though expected to get a committee okay to please farm and labor groups pushing it, is not expected to get anywhere on the floor of the upper chamber.

Minerals Purchase Act Stirs New Debate

SENATE DEBATE on the compromise mineral purchase act extension—which passed by a voice vote last month—made a legislative "record" to support future Washington talks on over-all minerals policy.

The compromise bill, authorizing Government support purchases of tungsten, asbestos, acid-grade fluorspar and columbium-tantalum, went through with only minor hitches, and is virtually assured of enactment.

But the debate on the Senate floor, likely to be repeated on the House side, emphasized the stop gap nature of the bill. Here are some of the points raised during its consideration in the upper chamber which preview arguments to come:

(1) Senator Henry C. Dworshak (R-Idaho) spoke for small tungsten producers when he offered an amendment to limit Government purchases to 5,000 units per month from any one producer. This was beaten by a narrow 32-22 vote margin.

(2) Opposition to any price supporting measure for raw materials from big eastern processors showed up when Sen. John J. Williams (R-Del.) tried to argue the bill down on grounds that the Administration had previously gone on record against any extension of domestic purchase programs.

(3) Most important, Sens. Dworshak, Arthur Watkins (R-Utah) and Wallace Bennett (R-Utah), Earle C. Clements (D-Ky.), and others got on record the dismay of other domestic producers whose materials were not included in the bill. Most of these, such as antimony, mica, mercury and metallurgical-grade

Congress Winds Up a Pre-Election Session

Critical nickel market shortage got new attention at Senate Small Business Committee hearings on small users' reports that they had to pay "grey market" prices and saw other users get supplies in excess of their needs by falsely claiming defense-rated contract orders. ODM director Flemming is refusing to put nickel back under Government allocation controls, however, on the grounds that end-use controls are not the answer to the problem. Increased production, says Flemming, is a solution. To this end, Nicaro production is being boosted, new expansion goals for industry have been set, and commerce is studying defense-rated orders for proof of essentiality.

Nevertheless, Sen. Wayne Morse (D-Ore.)—who headed the small business investigation—got the Defense Production Act extension amended to give the Administration more power in controlling allocations, if it sees fit.

With passage of the Defense Production Act extension and domestic minerals purchase authority, mining industry attention has shifted off Capitol Hill. Adjournment was scheduled for early July as this issue went to press—and no important mining legislation is pending.

Look for new, higher, stockpile goals for high-temperature alloys like tungsten, titanium, columbium-tantalum, cobalt and molybdenum.

Office of Defense Department comes up with new requirement figures. Defense will need more of these materials in jet aircraft and nuclear weapons. This will mean more Government purchases from domestic producers wherever possible.

Other domestic mineral purchase program goals will be raised shortly, in accordance with ODM director Flemming's promise to keep support purchases going (see above). Manganese buys will be the first to be boosted.

Government handling of its Nicaro, Cuba, nickel plant expansion—under General Services Administration—was criticized in a house Government Operations Subcommitte report issued last month by chairman Jack Brooks (D-Tex.).

The majority report, signed by the Democrat members of the Subcommittee, recommends a Justice Department probe of the situation to determine what further action should be taken concerning charges of political favoritism in awarding of GSA construction and employee insurance contracts, and wasteful management of the plant resulting in lost nickel production. Republican members of the group dissented—not from the majority's findings but from its method of conducting hearings. Among other charges, the minority said the findings were based on testimony of only a few witnesses, without giving fair chance for rebuttal. The hearing had been carried on for a period of several weeks.

fluorspar, will get continued Government purchase support by Administrative fiat of Office of Defense Mobilization. This was assured by director Arthur Flemming at hearings on the bill. The Senate debate merely served to put Flemming on public record that ODM would continue to help these items.

(4) Dworshak and others also called attention to Asst. Interior Secretary Felix Wormser's promise to come up with a long-range peacetime support program for domestic mining industries. The Idahoan also asked for a statement from new Interior chief Fred Seaton.

GATT Sees New Cuts in Some Metals Tariffs

TARIFF REDUCTIONS of 15% on aluminum, copper and steel were granted by U. S. negotiators at the recent Geneva meeting on General Agreements on Tariffs and Trade (GATT) in exchange for lower foreign duties on U. S. imports, particularly on iron and steel—semi-fabricated and manufactured forms.

First U. S. duty drops came last month, others in two successive years, 5% at a time. Duties on Canadian aluminum and aluminum alloys were lowered from 1.5c per lb to 1.25c, and on semi-fabricated shapes from the present 3c to 2.5c. Canada has looked toward U. S. aluminum markets for some time.

Should the tariff on copper again go into effect (the *E&MJ* average price would have to drop to 24c before it could), excise taxes on imports of ores, concentrates and forms would be dropped 15%. A drop of 0.3c (0.1c per year) if the present tax was granted. A number of copper-containing items got an ad valorem reduction of 15% (3% each year).

Lead and zinc duties remain the same.

Imported steel bars from Benelux, France, Germany, Italy and Sweden were granted concessions, also iron and steel wire rods. Canadian imports of steel ingots, blooms and slabs will get duty reductions.

Coupled with other tariff reductions and concessions, the U. S. agreed to cuts on approximately one-fourth its total dollar value imports of metals and manufactures. Benelux, France, Germany, Italy, Japan, Norway, Peru, Sweden, and the United Kingdom—in return—lowered rates on U. S. iron and steel exports.

Administration Appointments

PARALLEL with the naming of Fred A. Seaton to Secretary of the Interior, Congress received the names of Elmer F. Bennett, of Colorado for Assistant Secretary. Bennett is a former member of Interior's Legislative Council.

State Department has announced that A. L. Lynn, vice president, Island Creek Coal Co., is U. S. delegate to the Geneva meetings on European coal supply.

John C. L. Donaldson

Labor This Month

STRIKE-FREE COPPER BARGAINING: A rash of contract settlements in the non-ferrous mining industry makes it a good possibility that major 1956 negotiations will wind up peacefully. Bargaining between the Mine, Mill and Smelter Workers union and the major copper producers produced some initial surprises with contract terms that look like the industry's pattern agreements for the year. The early settlements came in the face of anticipated labor-management trouble, but the fire and fury was reserved for advance psychological warfare. When it came to hard and fast bargaining, both sides were ready.

Probable pattern settlement: When the final contract is wrapped up for 1956, it's likely that it will fit the pattern negotiated in the early settlements last month. The first such agreements were made between Mine-Mill and two of the biggest copper producers; Anaconda Co. and Phelps-Dodge Corp. with only minor differences, this is the way the new contracts in the industry shape up:

Agreement to run for three-years, with no re-opening clause. Wage hikes total about 24c; 10c the first year and 6 to 7c the following two years. Also increases for certain skills.

A new pension agreement providing $2.25 a month for each year of service. Substantial increased health and welfare benefits.

Improved vacations, 2½ weeks after 10 years of service. Improved night shift differentials.

Mine-Mill estimates the cost of the new contracts at about 34c an hour for the 3-year period. The quick settlements were a welcome event to the mine union officials, not only to stabilize their own inter-union problems with raiding AFL-CIO affiliates but also to allow them to concentrate on their legal problems with the Government.

NEW LEGAL TEST FOR MINE-MILL: Just when the mine union's trouble with the Government appeared to simmer down, the Supreme Court decided to take on the union's fight with the National Labor Relations Board. Winding up its last session until October, the high court put the Mine-Mill versus NLRB case on the docket for a ruling on its return. This means more legal problems for Mine-Mill attorneys who had recently been given a temporary reprieve in the union's trial before the Subversive Activities Control Board. The Board has postponed hearings on Justice Department charges that Mine-Mill is Communist-infiltrated and should be disbanded as bargaining representative in the non-ferrous industry. The case taken by the Supreme Court involves the NLRB's attempt to rule the union out of compliance with the Taft-Hartley Act and withdraw the authority it has given Mine-Mill to bargain. This is the Board's follow-up action after ruling that Mine-Mill officer Maurice Travis filed a false non-Communist oath—and the subsequent attempt to act against the union. In the last legal test before reaching the Supreme Court, the U. S. Court of Appeals ruled in favor of Mine-Mill with a decision that the NLRB had no authority to penalize Mine-Mill.

High court becomes labor-management bellwether: Almost by default, the Supreme Court has become the number one policymaker in the labor-management field. With Congress and the National Labor Relations Board abstaining from any substantative changes in present labor laws, the decisions of the top legal tribunal have become the focal point for any alterations in behavior. Here are the biggest decisions:

Employers must bargain with unions on stock option plans, where such plans are set up as a form of wages or other wage-related benefits. And, where management pleads inability to pay in collective bargaining, it must show the union its financial records to back the position.

Professional union organizers are barred from using private company parking lots. And, states may act against labor violence under their own state labor laws, even though the strikers may also be covered by Taft-Hartley.

Alan E. Adams

Peru Continues Political Stability

OUTCOME of Peru's presidential elections, scheduled for June 17, was not expected to exert any great force toward a change in the national attitude toward foreign investment which has made Peru "an oasis of political stability" in Latin America.

The three candidates ran in an election which marked the first major exercising of woman's suffrage, and which was characterized by a general public complacence during a period of prosperous peace. The man responsible for that condition, and still key figure in the election, is Gen. Manuel Odria, who seized power eight years ago, destroying the APRA party, led by the flambuoyant Victor Raul Haya de la Torre. APRA members were permitted to vote as individuals in the election but the party is still outlawed. The party is not known to have backed any one of the three candidates, but has been wooed to some extent by Odria.

• **Dr. Hernando de Lavalle,** a wealthy corporation lawyer with no previous political experience, was the candidate of a "National Unification Movement", formed by several parties including the Government Restoration Party. He is expected to follow the political and economic policies of Odria that brought U. S. and foreign investment to Peru. (Biggest mining ventures there now are the AS&R-Newmount-Cerro de Pasco-Phelps Dodge venture at Toquepala, Cerro itself, and Marcona iron.

• **Ex-president Manuel Prado** (1939-1945) led the Movemiento Democratico Pradista, also had the backing of several right-wing-splinter parties. A member of the wealthy Prado family of land-owners, publishers and bankers, he too is considered favorably inclined toward foreign investment that will maintain and increase Peru's wealth and prestige. He is considered by some observers to be "an Odria man" too.

• **Fernando Belaunde Terry,** young architect and former congressman, is the liberal leader of an independent party. He drew large crowds near the end of the campaign but was expected to run a poor third. He is an unknown quantity, but election figures of his campaign will provide study material for the nation.

All three candidates are committed to such fundamental policies as social and educational progress, highway and irrigation construction and incorporation of the Indian population into national life.

The latter problem is perhaps the biggest that Peru, as a growing nation, must face. The Indians of the *Altiplano* are now suffering from a drought in their farm lands; they are poorly fed and clothed and uneducated. While no drastic change in the political and economic should result from election of any of the three candidates, thoughtful Peruvians are concerned with the long-range needs for proper assimilation of "Los Indios".

Union Carbide Announces New Uranium Mill

UNION CARBIDE NUCLEAR CO. announced June 8 it would begin immediately a multimillion dollar expansion program to include construction of a new uranium processing mill at Rifle, Colo., and uranium upgrading plants at Slick Rock and Green River, Utah.

Joint announcement on expansion plans was made by Morse G. Dial, president of Union Carbide & Carbon Corp., and the AEC Grand Junction Operations Office, where the contract for purchase of concentrates from the new mill was signed.

Union Carbide Nuclear officials said the new mill would be "several times" the value of the existing mill, indicating an operation to cost between $8-million and $12-million. The present mill at Rifle will be dismantled when the new plant is ready for operation, the company said.

Union Carbide Nuclear also has a mill at Uravan, Colo., valued at about $2-million.

The company said it had planned to remodel and expand the old mill at Rifle, but that problems of space and tailings disposal resulted in the decision to build a completely new plant. The new plant is expected to be ready for operation late in 1957.

Details on the proposed upgrading plants were not given, except that they will use a special chemical process developed by the company.

It seems apparent that Union Carbide Nuclear's new program of uranium mill served by two "up-grading" plants is aimed at beating haulage costs on ore distance from concentrators.

Firm officials at Grand Junction stressed that the up-graders would not be concerned solely with "low grade uranium ores." "We may put some pretty good grade ores in the (up-grading) circuit," was the comment.

This has led observers to the conclusion that the end product of the up-graders would be a "high grade" ore-concentrate. The expected grade of product from such operations was not announced by the company.

Similarly, the fact that Union Carbide Nuclear, affiliate of Union Carbide & Carbon Corp., is using for first time on Colorado Plateau a chemical reagent in up-grading would indicate that elevated concentration—say between 15 and 20%—of values would have to be obtained to make the cost worth-while.

But basically, the saving on haulage to the Rifle location is significant.

The announcement, coming as it does on heels of the new procurement program promulgated by Atomic Energy Commission for period after March 31, 1962, *E&MJ*, June 1956, p 73) caused those in the industry who were predicting that the Rifle mill location would become uneconomic, to pause and ponder.

There are no known large uranium ore bodies left unexploited in general area of Rifle, where Union Carbide established a mill in 1925.

Union Carbide Nuclear spokesmen at Grand Junction confirmed that the new Rifle mill would be "three-quarters the size of our Uravan concentrator when present expansion there is completed." This latest round of expansion at Uravan makes that facility one of the largest on the Colorado Plateau.

So far as is known, Union Carbide's chemical up-grading plants at Green River and Slick Rock will be first of this type in history of commercial uranium reduction in United States.

Vanadium Corporation of America has a practical and effective sand-slime separation program at Monument No 2 mine in Arizona. But at last report, no chemical reagents were employed in this "circuit."

Union Carbide spokesman also let it be known that the up-graders would not be served solely with carnotite-type ores.

"We feel that there will be a number of ores, including the high lime ores in parts of Utah, which we can treat economically," a spokesman said.

Work on the up-graders and mill will begin immediately.

Completion is scheduled for fall of 1957.

Between 25-30 persons will be employed at each upgrading station, which also will act as a purchasing and receiving point for ores. Crushing, sampling et al will be carried out.

Union Carbide Nuclear will not buy ores below the .10% U_3O_8 specifications.

Fact that the firm is locating one up-grader at Slick Rock, relatively near the Uravan mill, indicates that significant design changes will be included in the new Rifle concentrator making use of the up-graded "ores."

Certain phases of the Union Carbide Nuclear contract extend past the March 31, 1962 program into the new procurement plan recently announced by AEC.

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AEC Contracts for 15th Uranium Processor

GRAND JUNCTION Operations Office of Atomic Energy Commission announces signature of a contract with Atomic Fuels Extraction Corp., Pocatello, Ida., leading to erection of a modest-sized concentrator at Bedrock, on the Dolores River in Montrose County, Colo.

Atomic Fuels is headed by Jack C. Turner, Moab, Utah uranium figure.

John R. Black, Pocatello attorney and company secretary, said the concentrator would cost $2½-million. Financing will be handled through J. G. White & Co., New York investment bankers, Black said.

He also disclosed that the mill contract runs until 1967. This would place the mill in the AEC's new $8 per lb ($U_3O_8$) procurement program after March 31, 1962, Black confirmed.

Western-Knapp Engineering Co, San Francisco, has design and general engineering contract.

AEC specified that operations would begin "in 10 months" after date of contract June 1, 1956.

The mill, employing a resin-in-pulp, acid leach circuit, will process carnotite (uranium-vanadium) ores from Tenderfoot Mesa, Beaver Mesa, Martin Mesa and Bull Canyon Area in Montrose and Mesa counties, Colo.

Black said vanadium will be recovered and sold by contracts already signed with purchasers in Japan and West Germany.

Black said Atomic Fuels Extraction's mill on the Dolores, 15 miles west of Uravan, Colo, and 5 miles east of the Utah state line, had reserves backing it up estimated at 1-million tons. Some 467,000 tons of reserves will be mined to support the venture during the next five years, he added.

JACK C. TURNER, 38, of Moab, Utah, is president of Atomic Fuel Extraction Corp., which has signed contract with AEC for construction and operation of a $2.5-million uranium mill at Bedrock.

Principal mines are Atomic Fuel's Mammoth on Tenderfoot Mesa, Montrose County, Colo. and Beaver Mesa Uranium Corp's properties on Beaver Mesa in Mesa County, Colo. Allan Simpson, Beaver Mesa official said this property now was producing at rate of 1,600 tons monthly and that with completion of a new 400 ft production shaft, output would be doubled.

Merger of Beaver Mesa Uranium Corp into and with Atomic Fuels Extraction is under consideration at the present time.

The mill also hopes to receive custom shipments.

United Kingdom Seeks Canadian Uranium

BRITAIN'S Atomic Energy Authority states that it is negotiating with Eldorado Mining and Refining Limited of Canada for the delivery of a "substantial quantity of uranium before March 31, 1962. It will represent a major contribution to the supplies of uranium required to meet programs for which the Authority is responsible."

The AEA added that the proposed arrangement was a continuation of the policy of tripartite co-operation between the United States, the United Kingdom and Canada which had existed from the beginning of the atomic energy program.

Colombian Government Uranium Deal

COLOMBIAN government is studying a contract for the exportation of uranium ore with the U. S. company, Electric Mines Corp. Up to now, according to Colonel Mariano Ospina, Minister of Fomento, uranium deposits have been discovered in the Santander Department near California but there are other signs of uranium deposits and through Instituto Colombiano de Asuntos Nucleares the government is proceeding wth studies both from the air and by land parties.

Utah U. Studies Ventilation Problems in Cage Movements

WHAT EFFECT, if any, does movement of a cage or skip up and down a shaft have on mine ventilation?

University of Utah's College of Mines and Mineral Industries is conducting experiments on this program at a "model" mine on campus of the University of Salt Lake City.

The mine, with 70-ft shaft and 700 ft of interior workings on two levels, was constructed for the school in 1935 as part of a federal works project.

Now it will be used by Veloy Peccioni, a student from Helper, Utah, in the ventilation experiment. Prof. John E. Willson, head of the college's department of mining and geological engineering, said mines with large adits probably would be unaffected by moving objects in the shaft so far as ventilation is concerned.

But he noted that in recent years, with development of smaller uranium mines, and consequently smaller shafts and entrances, movement of skip or cage could have some effect on air conditions.

To conduct the experiment at the model mine, Peccioni will use large blocks of wood of varying size to stimulate a cage in a shaft. Velocity and pressure of the air in the shaft will be measured in response to movement of the "cages".

Location of the ventilating equipment also will be moved various distances from the shaft in test of effect of air movement with upward and downward action of the cage.

The mine is ventilated by an electric fan displacing 22,000 cu ft of air per minute.

New Yugoslav Zinc Smelter

NEW "Zorka" zinc smelting plant has begun trial operation at Sabac in Serbia, according to reports reaching Vienna. The mill has been designed as an extension of the facilities at Cilli (Slovenia), which has an annual capacity of 30,000 tons of zinc concentrate. The new plant will initially operate at an annual rate of 6,000 tons of electrolytic zinc, 18 tons of cadmium and 12,500 tons of sulphuric acid, later to be expanded to 20,000 tons of zinc, 60 tons of cadmium and 40,000 tons of sulphuric acid.

Mining Calendar

Rocky Mountain Mineral Law Foundation, second annual meeting. Boulder, Colo., Aug. 2-4.

International Geological Congress, 20th Session. Mexico, D. F., Sept. 4-11.

Rocky Mountain Minerals Conference, third annual session, AIME, Salt Lake City, Utah., Sept 26-28.

German Society of Metallurgy and Mining, general assembly. Klagenfurt, Austria, Sept. 26-29.

American Congress on Surveying and Mapping and American Society of Photogrammetry. Denver, Colo., Sept. 30-Oct. 2.

American Mining Congress Mining Show, Shrine Exposition Hall. Los Angeles, Calif., Oct. 1-5.

Fifth National Clay Conference, University of Illinois. Urbana, Ill., Oct. 8-10.

44th National Safety Congress. Chicago, Ill., Oct 22-26.

Society of Exploration Geophysicists, 26th annual meeting. New Orleans, La., Oct. 25-Nov. 1.

New Mexico Mining Assn. and International Mining Assn. Carlsbad, N. M., Nov. 1-3.

Northeastern Branch conference, AIME. Hershey, Pa., Nov. 8-10.

American Society for Metals, second world metallurgical conference. Cleveland, Ohio, November.

(News Continued on p 130)

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IN THE U.S.

ALASKA

A new hard-rock mining venture is under way near Fox in the Alaska interior, and unofficial reports are that the gold-silver-quartz ore is bringing $340 a ton. This is the only major new mining operation to get under way in the interior so far this season. A total of 19 lode location certificates have been filed in the area of the ridge between Flume creek and Fox gulch near the head of Flume creek. First five claims were staked by John A. Miscovich, Oren Girdley and V. Maurice Smith; all of the filings have been made by veterans in Alaska mining circles.

Union Carbide Nuclear, having signed a contract for the I & L uranium property near Ketchikan some time ago, are now endeavoring to clear title to the claims. If successful, they plan a drilling program there. The I & L adjoins the original Ross-Adams discovery made early in 1955 on southern Prince of Wales Island.

Another major company has confirmed an interest in southeastern Alaska's rich Klukwan iron ore deposits which have been described as substantial. A U. S. Steel Corp. spokesman in New York said the Columbia Iron and Steel Co., subsidiary of U. S. Steel, has taken an option on the Klukwan deposits for investigational purposes.

U. S. Steel's resumption of mineral exploration work in the area of Ketchikan was revealed with the filing of four new limestone placer claims on Wasleigh Island west of Klawock. The four claims were filed by Furman H. Burge Jr., of Ann Arbor, Mich., who early this year transferred 38 other claims on Wasleigh Island to Columbia Iron Mining Co. of Utah, a subsidiary of U. S. Steel. Claims were filed with the U. S. Commissioner's office in Ketchikan.

A survey to explore the possibilities of a resource and economic appraisal as an aid to the development of northwestern North America was launched May 1 by the Arctic Institute of North America. Announcement was made by Graham W. Rowley, chairman of the Institute's board of governors. The survey, to last about one year, will be financed by a grant of $25,000 from Resources for the Future, Inc., of Washington, D. C.

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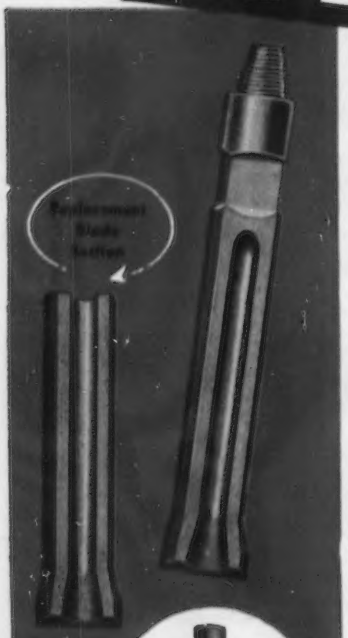

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ARIZONA

Western-Knapp Engineering Co., San Francisco, has been awarded contract to construct the new smelter for the Ray Mines Division of Kennecott Copper Corp. at Hayden, Ariz., it was announced at Salt Lake City.

While contract price was not announced, Kennecott previously has stated it planned a $40-million investment at Ray Division. The figure includes expansion of milling and mine facilities.

The smelter will treat 25,000 tons of copper concentrates monthly and will be completed in 20 months.

American Smelting & Refining Co. currently smelts Ray Division concentrates. Field work on the new smelter starts in 60 days.

ARKANSAS

Duncan, Dieckman, Duncan Mining Co., St. Louis, Mo., has acquired six more manganese-bearing claims on Eagle Mountain, near the mill site south of Mena in the the Ouachita Mountains. Total claims owned by the firm are now 57.

William G. Duncan, president, says the company will add a leaching plant to present facilities for production of manganese sulphate and manganese oxide.

CALIFORNIA

Construction has begun for the first tungsten mill in Indian Wells Valley, Inyo County. Indian Wells Valley Milling Corp. will operate it as a custom mill serving tungsten producers in the Mojave desert and Sierra Nevada mountain re-

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California *(Continued)*

gion. Mill site is the Donahue-Sturges ranch, four miles north of Inyokern. A well will be drilled to furnish water for use in reduction of ore. Mill will be operated on a round-the-clock basis under Grant Crow, superintendent. Officials include J. F. Davy, F. R. McKenna and D. Autremont, who formerly operated Kaweah River Tungsten Co., Porterville, Tulare County.

Coso Uranium, Inc., Long Beach, has shipped a 50-ton carload of ore from lake bed deposits near Olancha, Inyo County. According to W. O. Merritt, Coso president, the shipment came from a deposit which geologists estimate to contain in excess of 1-million tons of .15% to .20% ore. Test will be run for amenability and grade at the Salt Lake City plant of Vitro Uranium Co.

Coso plans to ship a second car from Discovery 12, a deposit of high grade granite with assays of .21% to .81%.

Custom milling has started at Apple Valley Mining & Exploration Corp.'s mill at Goler Heights, Kern County, according to Italo Maccari, mill superintendent. Milling operations were initiated with some 20 tons of ore from the Billie Burke mine at Randsburg. The mine is owned by Mrs. Kathleen Jewell and operated by the Ralston, Evans, Greene and Thorpe interests.

Central Eureka Corp. has purchased all of the capital stock of Flanders Mining Co., a Nevada corporation whose principal uranium-producing holdings are in the Gateway Mesa near Grand Junction, Colo.

Uranium Division of Great Lakes Oil & Chemical Co. of Los Angeles is reactivating its Kergon Mine in the Kern River Canyon as a result of court action early in May giving the firm clear title to the 200-acre property. Property consists of 10 uranium lode claims.

Shipments of ore to the AEC, interrupted last January because of the litigation, will be resumed following renegotiation of Government contracts.

Firm also announced construction has started on a major addition to the firm's bromine plant at Filer City, Mich., to cost around $350,000. The new facilities are expected to double plant output. Unexpected heavy production at the company's fifth brine well at Filer City has allowed reduction of earlier estimates on the number of wells to be drilled to supply the new facilities. As a result of the added bromine production, the plant has begun manufacture of Ethylene-dibromide.

COLORADO

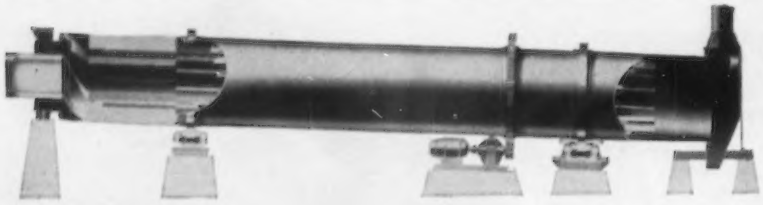
Magic Uranium Co., Salt Lake City, has sold its 200-tpd lead-zinc concentrator at Ouray, Colo., to Machinery Center, Inc., Salt Lake City.

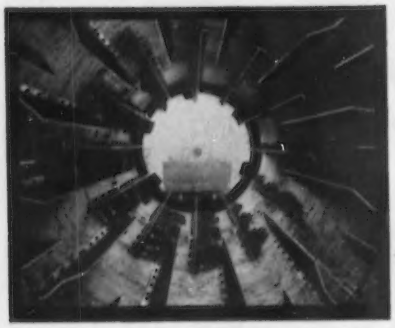
The firm had purchased the concentrator from American Zinc, Lead & Smelting Co. It had served in past a number of smaller properties in the Ouray district.

Beaver Mesa Uranium Corp. now is shipping approximately 3,000 tons of ore monthly, president Alan M. Simpson of Grand Junction reported in a letter to stockholders in May. About half that production is from the Cherokee shaft, which is producing ore averaging .30% uranium oxide and 1.20% vanadium.

Rehabilitation of the Vindicator shaft, on the northeastern edge of the Cripple Creek District, will start at once if water in the mine has receded because of the drainage tunnel lateral now being driven, it was announced by Merrill E. Shoup, president of United Gold Mines Co., owner of the Vindicator mines and several of the other large mines in the district.

Vindicator was shut down several years ago when excessive water made mining prohibitive in spite of the fact that there was rich ore in the Ready Money vein system at the 2100-ft depth. Mr. Shoup said that a check on the water situation can be made via the old Roosevelt Drainage Tunnel, which is about 1,000 ft above the present Carlton drainage tunnel lateral. Then, he said, a crew from the Cresson mine would be used in the rehabilitation work at the Vindicator. The water check will be made at once.





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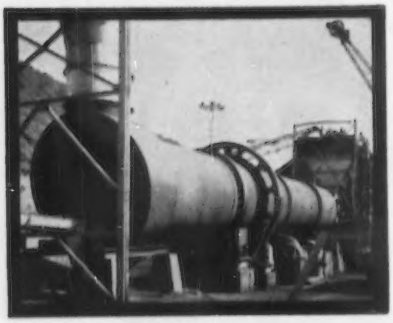

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Colorado *(Continued)*

Shoup said that some good assays have been realized from work being done in the Vindicator lateral, with grab samples running from $24.50 to $52 a ton in gold. The Vindicator and the adjoining Golden Cycle mine produced over $50-million in gold down to the Roosevelt drainage level.

Antonides Bros. Mining Co. of Glenwood Springs report that Union Carbide Nuclear Co. has commenced drilling on a portion of the 130 claims that were optioned from them in the Lay-Maybell area of Moffat County, Colorado. Antonides Bros. still hold 50 claims adjoining those that were optioned and plan a drilling program during the summer.

A half-million dollar expansion program is planned for the Atomic Energy Commission concentrate sampling plant and the analytical laboratory at Grand Junction. Both establishments are operated by Lucius Pitkin, Inc. of New York. The total expansion cost will amount to $660,000. Lab expansion will cost $362,000 and bids will be asked after the first of the fiscal year, July 1, if the move is approved by the Senate.

Announcement that DMEA has approved a $16,000 contract for the Jimtown Mining Co. has bolstered hopes in the Boulder County historical mining camp that a uranium boom may be in the offing. The contract, of which the Government's share of $12,000, will mean the Jimtown Mining Co. can start a tunnel for deep exploration, according to Clark H. Clark, engineering partner in the firm.

United Mining & Leasing Corp. operating its property at Central City through the old Carroll shaft, according to president Van R. McKay, has made a discovery of pitchblende ore on the 320-ft level of its mine which is being operated as a lead-zinc producer. "The vein, where opened," says president McKay, "carries a high radioactive count through a width of 4 ft, with streaks of sooty pitchblende and uraninite ore, which varies in width from 8 to 14 inches."

Park City Consolidated Mines Co. of Utah with aid from a Government loan is outlining the extent of the Union vein orebody on Keystone, Colorado properties near Crested Butte.

Dallas Uranium & Oil Corp. reports continuous shipments being made from its Jodie mine in Mesa County. Officials say the property began shipping in December 1954 and has been continually shipping since that time without shutting down. Ore being shipped at the present time is averaging more than $50 per ton. A limited amount of drilling was done last fall in the Talahassee Creek area of Fremont County, with inconclusive results and more work is expected this spring on the 10 claims held by Dallas in that area.

Treasure Mountain Inc., new Nevada mining group, has begun development of four properties in the Eureka mining district, San Juan County. Included in the new firm's program is:

Rehabilitation of the mine and mill at Lead Carbonate mine; uniting of Gold King mine with Golden Monarch, Pride of Bonita and Lead Carbonate for drifting into the nearby Sunnyside Mine; development of Monarch, Pride and King. Mill capacity is planned for 200 tpd. Offices of the firm are at Silverton.

FLORIDA

American Cyanamid Co. will build a 200,000 ton per year triple superphosphate plant at Brewster, on an existing Cyanamid site where phosphate rock is mined. Construction, already underway, is scheduled for completion in mid-1957. Design and construction of the facility will be by Chemical Construction Co. in collaboration with Dorr-Oliver.

IDAHO

University of Idaho college of mines has established a permanent summer field camp for geology and mining students in Custer County near Mackay and has enrolled about 15 students for the first summer session, June 14 to July 7. Instruction and training in field techniques previously given through short field trips during the school year will now be

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Idaho *(Continued)*

handled through the new camp. Camp faculty this year consists of J. C. Dotson, assistant professor of mining engineering, and K. E. Grim, instructor in geology.

Directors of Lucky Friday Silver-Lead Mines Co. have authorized deepening of the new three-compartment shaft at the Lucky Friday Mine east of Mullan an additional 700 ft to the 3,000 level. Cutting of waste pockets for handling the shaft waste and preparation of stoping areas in which to dispose of the waste as back-fill are now in progress, and actual sinking operations are expected to be underway by about mid-summer. Company is also planning to start westerly exploration this year into adjoining Gold Hunter property, held under lease from Day Mines Inc.

New Rainbow Mining Co. has opened a small ore shoot about 35 ft long, averaging 18.6 oz silver per ton, in the new west drift at the old Weber Mine in the Lakeview District of Bonner County. The new footwall heading is now within 200 ft of its objective.

Potash Company of America will go ahead with plans to build either a treble superphosphate plant or elemental phosphorous furnace near Paris, Idaho, whether phosphate lease is raised by Congress from 5,120 to 10,240 acres or not.

Such is the view of F. O. Davis, Carlsbad, N. M., executive vice president of the Denver-backed concern.

The firm now controls 1,100 acres of phosphate land near Paris above Bear Lake on which it is carrying out experimental work to determine cost of open pit mining.

Potash Co.'s proposal, embodied in a bill before the U. S. Senate subcommittee on mines and mining, is opposed by representatives of San Francisco Chemical Co., dominant producer in the tri-state area of Utah, Wyoming and southern Idaho.

D. L. King, San Francisco president, recently testified that such type mining would lead to waste. It is San Francisco Chemical's view that open pit mining on a 10,240 acre tract would lead to "high-grading" of ore.

Davis contends to talk of waste is foolish in terms of (1) 5.1-billion tons of proved mineable phosphate reserves in U. S. with possible additional recoverable reserve of 49-billion tons and, (2) fact that Government, as it does in oil and gas and other mineral leases, may cancel operation if there is waste of valuable resource of public domain.

Hecla Mining Co. will start underground exploration this year on the Princeton Mining Co. property in the Hunter Mining District east of Mullan. Plans call for a crosscut tunnel to explore beneath surface bull-dozer cuts with exposed good lead-silver-copper mineralization. The tunnel will gain about 125 ft of depth on the big vein structure which traverses Princeton property throughout its two-mile east-west length. Hecla, in association with the Bunker Hill Co., has entered into a contract to explore and develop the property for a 60% interest therein. The Princeton claims adjoin on the southeast the Silver Mountain Lead Mines property which Hecla and Bunker Hill are currently opening to a depth of 2,000 ft under a 75-25 profit deal.

Metropolitan Mines Corp. has made arrangements to have a 1,000-ton stockpile of zinc-lead and lead-silver ore processed at the nearby Hull Lease mill on Canyon Creek northeast of Wallace. Ore was extracted from the old Black Bear Mine, largely from development work designed to open some new stoping areas at the former producing property. The old mine is adjacent to American Smelting and Refining Co.'s Frisco property and Metropolitan operates it under an agreement with Black Bear Silver-Lead Mines Co.

Polaris Mining Co. is making preparations for deeper exploration of the Good Hope area of the Chester vein in Silver Dollar Mining Co.'s silver belt claims in the Coeur d'Alene District. Stations for down-hole diamond drilling will be cut on the 3,000-ft level and drill holes will be projected downward through the vein structure, particularly in the area beneath the short ore zone which has been exposed on the 3,000 and upper levels. Polaris operates the area for Silver Dollar under a profit-sharing agreement.

KENTUCKY

William P. Drake, president of the Pennsylvania Salt Manufacturing Co. announced completion of the Dyer's Hill fluorspar mine in Crittenden County. The development of the mine and the expansion of milling facilities in the same area began early in 1954. Both units were designed by the company's Central Engineering staff.

MICHIGAN

Tracy mine at Negaunee, Jones & Laughlin Steel Corp., a new operation which is now well developed, won the corporation's mine and quarry safety award for 1955. The presentation was made at the mine May 8 with several Jones & Laughlin officials from Pittsburgh present. Robert Braund, Negaunee, is manager of the J.&L. Michigan Ore Division.

Peter Kiewit & Son have resumed mining ore at the Fortune Lake open pit mine of Pickands, Mather & Co. near Iron River on the Menominee Range. They began stripping the Fortune Lake property—an old underground operation—in July 1952. Their stripping contract, which was for five years, is expected to be completed in December of this year. The pit area extends over two forties and present operations include an area ¼ mile long by 400 ft wide. Stripping is from 75 to 90 ft in depth. First ore was shipped in August 1953, and—up to this season—a total of 828,224 tons have left the mine.

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cut temporary drift support costs one-third

Climax Molybdenum Company is using CF&I Rock Bolts and Realock® Chain-Link Fabric to save 30-35% on temporary slusher drift support. Developed by the Climax Planning and Mining Departments, the new method:

- Enables miners driving drifts to do their own rock bolting *with the same machines used to drive heading.*
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The CF&I Rock Bolts used by Climax are 7 ft. long ¾ inch diameter bolts with Pattin Expansion Shells. They have left-hand threads to allow tightening by the left-hand rotation of the drilling machines. A special adapter consisting of a machine chuck and square socket welded together is the only special accessory needed for this operation.

This is just one of the many jobs being performed by CF&I Rock Bolts—known throughout the mining industry for their dependable performance. Why not get the full details on how you can use CF&I Rock Bolts to advantage in your own mining operations? Just write the nearest sales office listed below.

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3431

Michigan *(Continued)*

Michigan Institute of Geology met at Houghton May 11 with 174 men attending. Dr. A. K. Snelgrove, Michigan College of Mining & Technology at Houghton, was general chairman. Dr. C. E. Dutton, U. S. Geological Survey, acted as chairman of the meetings. Among the several papers given were: "Copper Mineralization of the White Pine Copper Mine," by John R. Rand, consulting geologist, Yarmouth, Maine; "Geological Factors Affecting Beneficiation of Lake Superior Iron Ores," M. E. Volin, Bureau of Mineral Research at Michigan Tech.; "Trends in Geochemical Exploration," by H. E. Hawkes, Jr., of Massachusetts Institute of Technology; and "Magnetic Prospecting for Iron Ores," W. George Wahl, consulting geologist, Willowdale, Ont.

MINNESOTA

M. A. Hanna Co. has announced that the name of its Parcel 3 mine has been changed to the Hunner mine in honor of Earl E. Hunner, former general manager who retired in August 1951. From 1912 to 1917 Mr. Hunner was with the Great Northern Iron Ore Properties as chief engineer and, in 1913, general supt. He went to the M. A. Hanna Co. in 1917 as assistant general manager under James D. Ireland and, soon after, became general manager. He held that position until 1946 when he was made executive consultant for the Lake Superior district. Mr. Hunner now lives in Duluth.

Pickands, Mather & Co. is shipping ore from all six Minnesota and Michigan ranges: one on the Vermilion range, the Zenith underground mine, which was begun in 1892; ten on the Mesabi range, one of which—the Albany—is an underground operation; three on the Cuyuna, including the Rabbit Lake mine which made its first shipment in 1952; six on the Gogebic range, all underground mines and all in Michigan except the Cary which is in Wisconsin near the west end of the Gogebic; one, the Volunteer, on the Marquette range and two on the Menominee range: the Buck group near Iron River, underground, and the Fortune Lake, an open pit, also near Iron River, a total of 23 operating properties.

Minnesota Iron Mining Division of Jones & Laughlin Steel Corp. will construct a plant at the Hill-Annex mine, Calumet, for treating the tailings which have accumulated in the original tailings basin during the 35 years or more that the basin served the old concentration plant. There are millions of tons of fine tailings running all the way from a near-shipping quality to a negligibly low iron content at the dam end of the large basin. The tailings are owned by the Great Northern Iron Ore Properties. The plant will be designed and constructed by American Steel Dredge Co., Inc., with Western-Knapp Engineering Co. of Hibbing doing the actual engineering and construction work. It is expected that the plant will be ready for operation in the spring of 1957.

Directors of the Great Northern R.R. have approved a plan by which the road will cooperate with the University of Minnesota and the University of North Dakota in research work designed to discover an economical method of concentrating non-magnetic taconite of the Mesabi range. President John M. Budd says that Great Northern's interest will be confined to research and that the road would not participate in any pilot plant development.

On May 2 the state executive council approved an application by the Western Mining Co. (Pickands, Mather & Co.) for an extension of its lease of the Tioga No. 2 mine near Grand Rapids to Dec. 31, 1974. The agreement permits the company to ship the fine and coarse concentrates separately—a practice which is being quite generally adopted. Ray Nolan, director of Minnesota State Lands & Minerals Division, reported that the property contains an estimated 1,037,600 tons of wash ore concentrates and 3,305,800 tons of heavy-media concentrates. First ore was shipped from the property on June 7th, 1955, with 405,759 tons produced that year.

Seven mining operations of Oliver Iron Mining Division have received Joseph A. Holmes certificates of honor. They are the Pilotac open pit (taconite); Mountain Iron crushing plant; Monroe No. 12 open pit; Godfrey underground mine (not operating at present); the Hibbing-Chisholm district; the Canisteo district and the Arcturus concentrating plant at Marble. The awards were presented by John A. Johnson, Washington, D. C., chief of the U. S. Bureau of Mines Safety Division.

MONTANA

Lisbon Uranium Corp., Salt Lake City in which Atlas Corp. has minority control, announced signature of lease and prospect agreement with Bice Mining Co., Lovell, covering exploration on 100 uranium claims in the Pryor Mountain area on Wyoming-Montana line.

Umont Mining Co. has taken lease and option on a manganese-silver property in the Independence area of the western part of the Butte mining district.

Dooley P. Wheeler Jr., general manager, said option was obtained from Nelson and Irving, Butte mining partnership. The properties are being rehabilitated in connection with further examination.

Umont (Utah and Vermont) has its corporate headquarters in Burlington, Vt.

NEVADA

Second offering of a $2,000 scholarship to a graduate of White Pine High School has been made by Consolidated Coppermines Corp., Kimberly. Two winners of the 1955 offering are now enjoying its

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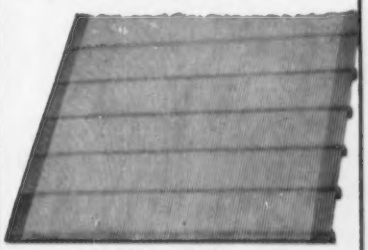
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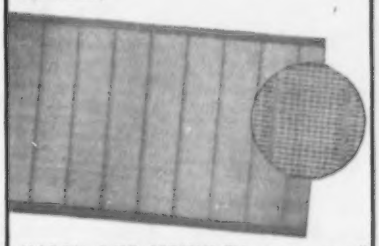
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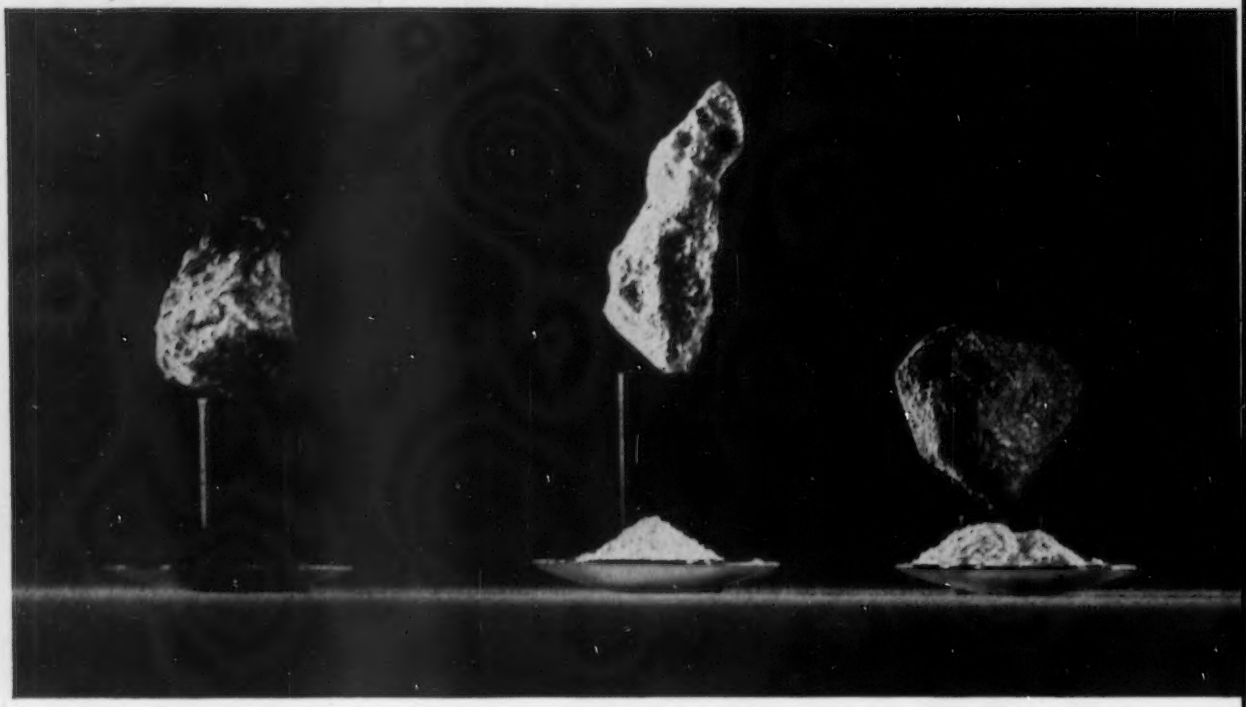

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ECONOMICAL AND EASY TO USE—A little Separan 2610 goes a long way. Normally, a few hundredths of a pound per ton of solids yields optimum results. And it's as easy to prepare and apply as it is economical! Stock solutions require no heat or preservatives. A new disperser enables you to prepare large amounts of stock solution with a minimum of labor—a mechanical mixer is not required. In addition, this synthetic, organic polymer is effective in both acid and alkaline circuits; presents no hazard in normal use; and adds no excess bulk.

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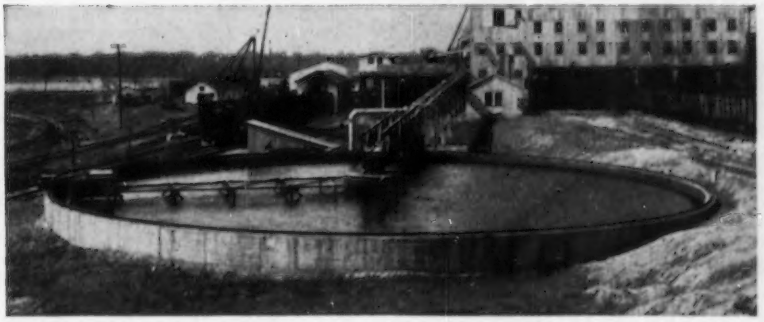

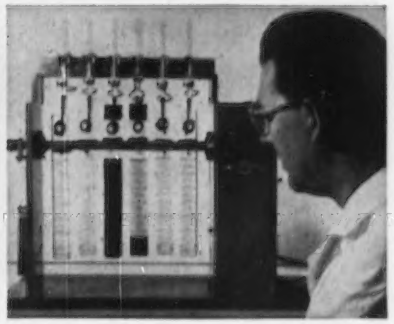

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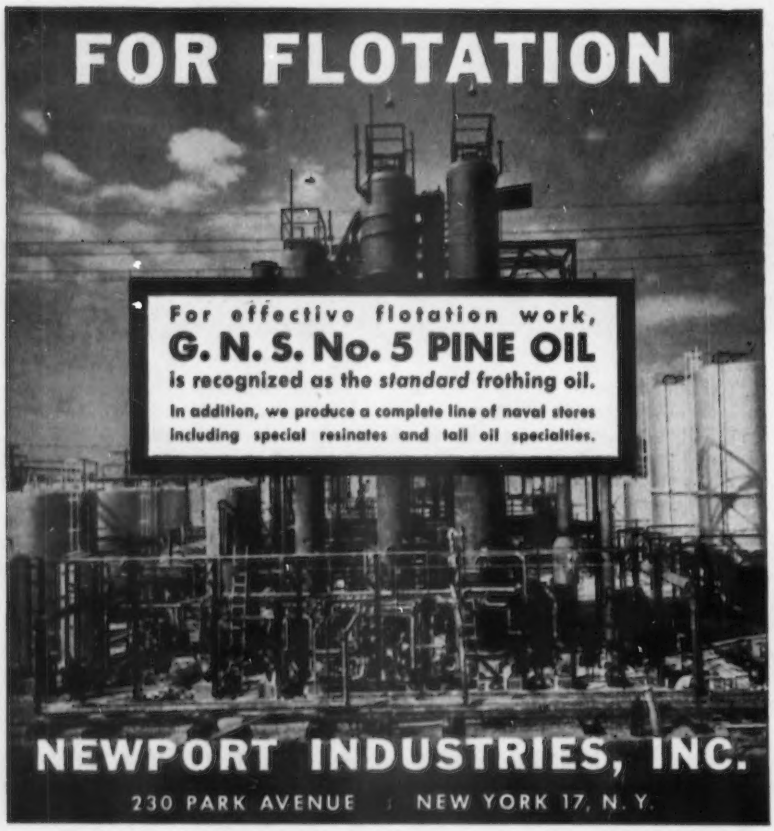
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Nevada *(Continued)*

benefits, which consist of $500 per year for four years of college.

A. J. O'Connor, vice president and general manager, notes that the student is chosen by a panel of three; one member of the school faculty, one member representing the county at large and one member of the corporation.

Getchell Mine Inc., which operates the Getchell mine and mill in Humboldt County, reported during May that its net income during 1955 before provision for taxes was $1,153,327.28. The firm ended the year with current assets of $2,378,177.80, as compared with $1,487,-885.23 in 1954. In his report to stockholders, George Wingfield, president of the company, said that during the year the Granite Creek mine produced tungsten ore steadily from its 200, 300 and 500-ft levels, and underground development in the Moly Hill mine met with encouraging results.

A total of 186,736 tons of tungsten ore were mined by the company from its own properties, and 23,818 tons were purchased from outside producers on a custom ore basis. A total of 141,814 tons of ore were treated on a fee basis by Union Carbide Nuclear Co., formerly U. S. Vanadium.

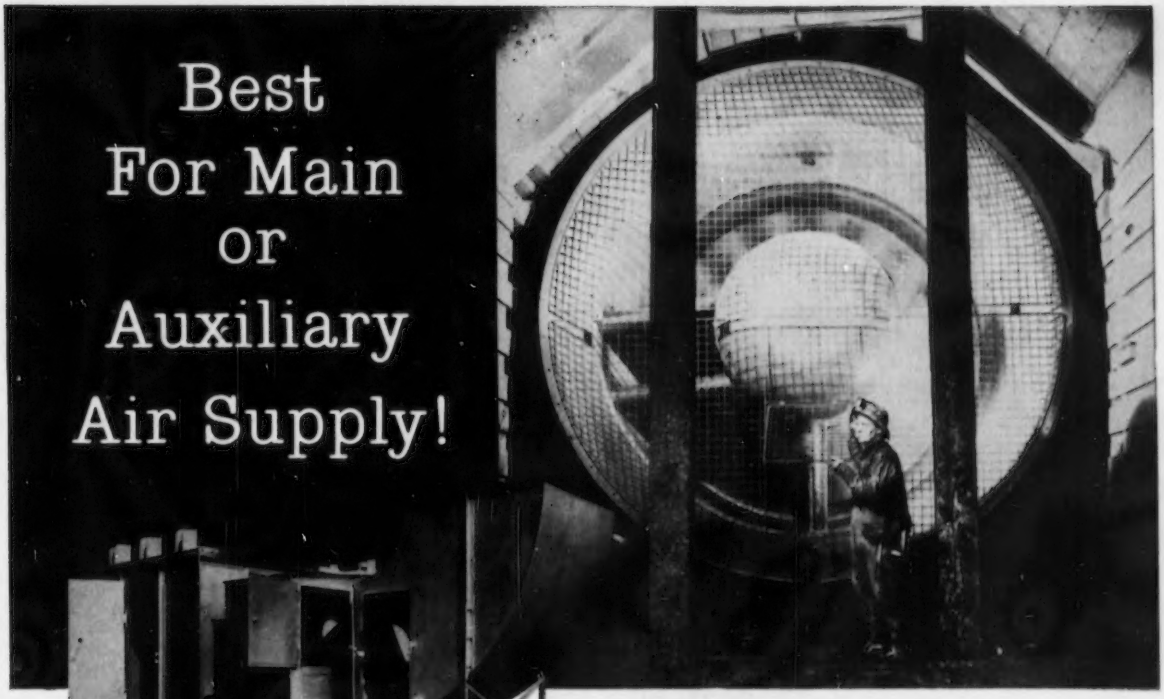
Apex Uranium Co. shipped a second car load of ore from its property near Austin early in May and assays by Black & Deason, of Salt Lake City showed a .202 content. The ore was taken from the outcropping of the Diamond Claim which is about 1500 ft east and 400 ft higher from the Rundberg stope, and returns from the shipment were close to $5,000, according to Hugh F. Cameron, superintendent of operations. Apex company is currently running four development headings, and expects to make ore shipments at an increasing rate as the summer progresses.

Sam S. Arentz, mining engineer long connected with Combined Metals Reduction Co. in Lincoln County, has joined forces with the Shawano Corp. in the development of property and erection of a mill at the Bretz mercury mine near McDermitt near the northern Nevada line. After conferences with J. P. Hart and Jay Carpenter, principal owners of the property, it was decided to erect a 70-ton mill. Arentz will be mill manager, Carpenter will be consulting engineer, and Hart will continue to represent the Shawano interests.

Bristol Silver mine in Lincoln County has discovered a rich orebody on the 500-ft level which is described as one of the most significant finds in recent years. Don Werner, leaser of the property, says two raises, approximately 80 ft apart, have exposed ore upward for more than 150 ft, which appears to go all the way to the surface. Engineers have estimated the orebody at from 15,000 to 40,000 tons. The find is in a newly developed section of the mine.

White Caps Mining Co. made its first shipment of mercury ore from its prop-

Best For Main or Auxiliary Air Supply!



Above: 9′ Joy Axivane Mine Fan teams with an 8′ Joy Fan to provide main ventilation system for Climax Molybdenum Company mine.

Left: 10 H.P. V-belt drive Joy Axivane Fan moves 50,000 feet of air each minute. Ideal for auxiliary or small-mine ventilating duty. Photograph courtesy U.S. Bureau of Mines.

JOY AXIVANE MINE FANS

MAIN AIR SUPPLY Low operating speed, wide operating range, simultaneous . . . and easy . . . blade adjustment, and ready bearing accessibility assure you efficient, dependable ventilation for your mine. The big 9′ Joy Axivane Fan illustrated at top right is in operation at Climax Molybdenum Company's mine in Climax, Colorado. This V-belt driven fan produces air volumes from 81,000 CFM to 770,000 CFM, and above, with pressures up to 15″ w.g. It teams with an 8′ Joy Fan to furnish the main air supply for the Climax mine.

AUXILIARY AIR SUPPLY The 10 H.P. V-belt drive Joy Axivane Fan, illustrated at top left, moves 50,000 feet of air each minute with total pressure of .75 inches. Fitted with reversible motor, this efficient air-moving machine is ready to exhaust stale air or draw in fresh air for the working crews. Remote-controlled adjustable blades allow you precise control of air volume and pressure. It is designed for auxiliary ventilation service in a large mine or for primary ventilation in a small mine.

The vaneaxial design of Joy Mine Fans conforms to the latest formulae of aerodynamics . . . to give you increased efficiency and greater power savings. Joy Axivane Mine Fans are available in sizes up to 12′ in diameter, with air volumes up to 1,120,000 CFM. For full details write to **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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Nevada *(Continued)*

erty near Manhattan in Nye County during May, and got an assay of 46 lb per ton, which brought a ton price of about $175. The ore was taken from an inclined shaft about 400 ft from the White Caps shaft, an old producer of many years standing. Work is being pushed on the White Caps mine to get it back into production after a long period of disuse. W. R. Noack, of Reno, is president of the company operating the property.

Homestake Mining Co. has signed an option with Paul Montgomery, Wells, covering development of several scheelite claims south of Wells.

The claims were located July 16, 1955 while Montgomery was pursuing his hobby—prospecting in the hills.

The six month's option signed by Donald McLaughlin, Homestake president, was taken following inspection of the properties by Paul Henshaw, assistant to president of Homestake, and Richard Stoehr, engineer of Reno.

NEW MEXICO

Shattuck Denn Mining Co. has decided to sell its acid grade fluorspar mill at Las Lunas, because of inability to compete with foreign-produced material.

The 400-tpd plant was operated by an S-D affiliate, Zuni Milling Co.

Machinery Center, Salt Lake City, will buy the mill for resale.

Shattuck Denn said in company annual report: "The market for the mill's product, acid grade fluorspar, has not improved and continues to be dominated by imports from abroad. Efforts by domestic fluorspar producers to obtain relief from such imports have so far been unsuccessful."

NORTH CAROLINA

Mica producers in the Spruce Pine area are going ahead with plans for extension of their production in the light of ODM's new rulings on mica purchases. The new order, which calls for extension to June 30, 1962, revived local operators' enthusiasm and encouraged new study of mines which had formerly been permitted to close.

Local spokesmen said the new purchases would mean an additional $500,000 per year for sheet producers and $50,000 for the operating contractor at the Spruce Pine purchasing depot.

OREGON

Comstock Uranium-Tungsten Co., Inc., working the Haggard and New chromite mine in Grant County, made the first ore shipment from central Oregon in mid-April to start the chrome mining activity in Oregon. Full scale operations are slated to get under way by mid-May when weather permits ready access to the mine property. The shipment was by truck from the mine and mill supervised by E. E. W. Kearly.

Construction of a concentrating mill for treatment of chromite began at Canyon City for ore from the William Gardner ranch a mile northwest of the Haggard and New property. Al Dunn, who has the prospect under lease, began development last season. He shipped 16 tons of concentrate from a test mill-run conducted late last year.

H. K. Riddle is continuing underground exploration work on the Jordan brothers cinnabar claims on Bully Creek, Malheur County. S. P. Wilson of Burns is in charge. Riddle is from Vale.

The cinnabar prospect on Vale Butte, Malheur County, is being drilled by Uranic and Strategic Minerals Co., Inc., Boise, Idaho. William Schierding is manager of the operation.

UTAH

Lookout Mountain Mining & Milling Co. and United Mines Inc. of Kellogg, Idaho, have had an exploratory drilling program under way since early May on their extensive property holdings in the Elk Ridge

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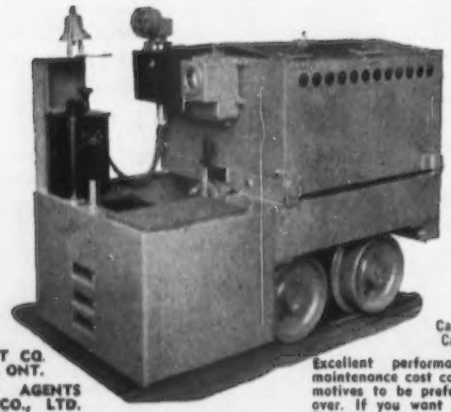

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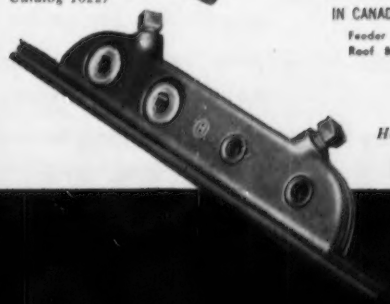
String trolley wire first, follow up with feeder cable as it's needed—using just one fitting, just one tool (a hex wrench) for both jobs.

Three sizes accommodate 4/0 to 1,600,000 cm feeder cable, all three hold any size trolley wire.

For 4/0 to 500,000 cm feeder	Catalog 22465
For 750,000 to 1,000,000 cm feeder	Catalog 22466
For 1,200,000 to 1,600,000 cm feeder	Catalog 22467

Hollow Screw Clamp
Catalog 16227



Hollow Screw Splicer
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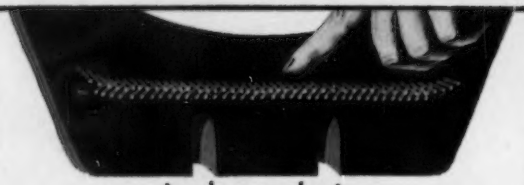

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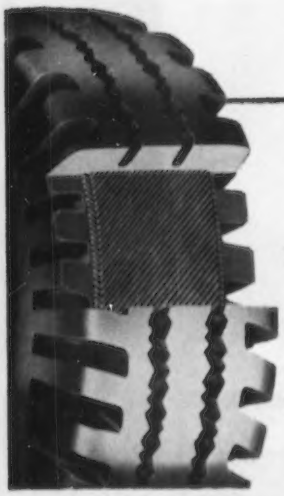

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- ★ New Multi-Edged Design—gives greater highway skid control
- ★ New, Deeper Shoulder Vents—dispel heat for cooler running
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You are looking at an entirely new kind of truck tire—the new U. S. Royal Super Fleetmaster. Its exclusive Safety Steel Shield makes it so immune to road hazards that it runs over spikes and razor-sharp axblades without losing a pound of air!

Put the new Super Fleetmaster on any wheel and watch it outperform! On front wheels, it gives greater stability. On drive wheels, it delivers extra traction. On trailing wheels, it lasts for recap after recap. *Standardize* on this great new tire—and reduce inventory expense!

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SAFETY STEEL SHIELD*

Mount this great new tire on dump trucks, transit mixers, log haulers...on any wheel exposed to heavy impacts, sharp objects, murderous terrain. You'll enjoy fewer tire failures, less downtime expense and greater service dependability.

Right now, your U. S. Royal Dealer has the new Super Fleetmaster with exclusive Safety Steel Shield in sizes through 11.00. See him—as soon as you can. And remember, you can specify "Super Fleetmaster" on your new equipment!

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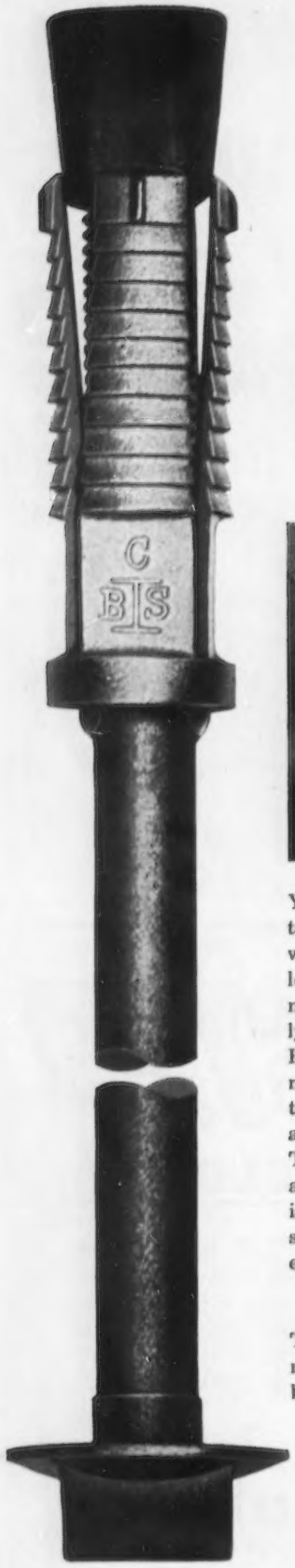

Headed Bolt with Expansion Shell Helps Promote Mine Safety

Your mine becomes a safer place in which to work, with severe roof falls unlikely, when you adopt roof-bolting, using Bethlehem's square-head roof bolt. This method of roof support anchors overlying rock, keeping it firmly in place. Roof-bolting, installed quickly and at moderate cost, has other advantages, too. Ventilation is improved, due to the absence of old-fashioned, bulky supports. There's less need for storage space, both above and below ground. And production is increased, because there's more clear space in which to operate mechanized equipment.

Made in Three Types

The Bethlehem square-head roof bolt is made in three types: (1) ¾-in. diam carbon steel, with minimum breaking load of 20,000 lb; (2) ⅝-in. diam high-strength, with minimum breaking load of 20,000 lb; and (3) ⅞-in. diam high-strength, with minimum breaking load of 40,000 lb.

All three types are used in conjunction with a leaf-type malleable-iron shell, which expands when tightened, locking the assembly in the hole. A square roof-plate provides added support. A hardened washer, furnished with the assembly, reduces friction between the bolt head and the roof-plate.

The best way to get started on a roof-bolting program is to talk things over with a Bethlehem representative. He'll be pleased to call at your convenience. Just get in touch with our nearest sales office.

Slotted Roof Bolts

In addition to the headed bolt, Bethlehem makes a 1-in. diam slotted roof bolt, for use where maximum strength is desired. The bolt is also suitable for pillar bolting. It is furnished with a 6-in. forged slot, and comes with a steel wedge which spreads the slotted portion when the bolt is driven. Bolt has truncated-cone point to prevent thread damage. It is normally furnished with American Standard regular square nut.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Utah *(Continued)*

area of San Juan County. The tests are being carried to an average depth of about 350 ft, under the direction of C. R. Ranney, geologist and Eugene Iverson, mining engineer. Joint holdings of the two firms in the area include some 3400 acres "checkerboarded" over an area embracing about 10,000 acres.

Western Silver-Lead Corp., Square Deal Mining & Milling Co., and Uranium Mines, Inc., all of Wallace, Idaho, have started a seven-hole exploratory drilling program on their jointly-owned Phoenix property in the Big Indian District of San Juan County. All the holes are being drilled along the southern boundary of the property, less than 1,000 ft from a commercial ore disclosure on Homestake Mining Co.'s Alice claims. Western Silver and Square Deal each have a 25% interest in the venture, while Uranium Mines holds the remaining 50%.

Lisbon Uranium Co., Salt Lake City, is completing negotiations with bidders for sinking of a 600-ft, two compartment shaft serving its Ike and Nixon claims in Big Indian District, San Juan County.

A. P. Kibbe, president, said the shaft would exploit a 135,000-ton orebody, average grade of ore in which is "above 1%" U_3O_8.

The production project will be named the "Ike" shaft and sinking will be supervised generally by Hidden Splendor Mining Co.

Lisbon is 70% controlled by financier Floyd B. Odlum's Atlas Corp.

A second 600-ft shaft, which may have three compartments, will be commenced later this year 1 mile north of the Ike shaft location, Kibbe added. This project will serve the Judy Lee-Columbia orebodies.

Norman Rogers Mining Co., Helena, Mont., plans to start shipment within 60 days of siliceous copper ores from an open pit development in the Newhouse area of the Milford district, Beaver County.

Rogers, firm proprietor, says the shipments of 3% ore or better will be made to Garfield smelter of American Smelting & Refining Co., near Salt Lake City.

A 1½ cubic yd shovel is now completing removal of overburden.

Production of 500 tons of average grade uranium ore is projected within 30 days at the Cord mine, Big Indian District, San Juan County, by E. L. Cord Enterprises, Inc.

George Teal, general manager, said Boyles Brothers Drilling Co., Salt Lake mine contractors, had completed shaft and station cutting in May.

Teal confirmed that the property, which he says has 500,000 tons of reserves, has been much sought after by those in milling business. Latest approach, he said, was by Texas Co. No negotiations with that firm are current, he added. Others who have expressed interest in the mine include Homestake Mining Co., Atlas Corp., Vitro Corporation of America, American Smelting & Refining Co., Anaconda Co.

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They protect costly machinery against tramp iron damage by pulling iron out of the deepest burdens on high-speed belts, where other types of magnets are ineffective.

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"In-Line" models extract iron parallel to burden travel and at the same speed. Rail sections or other long pieces are removed before the trailing edge can rip the belt.

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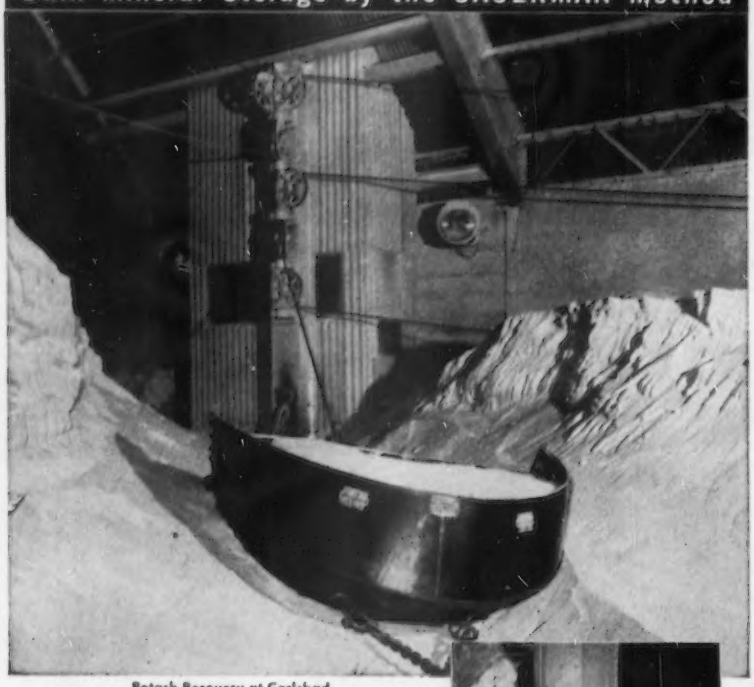
Bulk Mineral Storage by the SAUERMAN Method



Potash Recovery at Carlsbad

Remote Control

How Sauerman Scraper Storage Reduces Costs

200,000 tons of triple superphosphate are produced each year in this new Florida plant. It is delivered by overhead conveyor to a 329′ x 146′ storage building of 35,000 ton capacity. The material is then stockpiled and reclaimed by a 2½ cu. yd. Sauerman Scraper at a rate of 150 tph.

Here's how a Sauerman Machine cuts costs:

One operator, located in a safe station overseeing the entire area, can recover practically 100% of all stockpiled material.

All highly machined parts, hoists and motors can be located outside of the building and protected from corrosion and dust.

When parts are replaced—sheaves, clutch or brake linings—the machine is restored to practically new condition, even though it may be twenty or more years old.

Only the Crescent scraper and cables contact the material. The scraper machine can be designed to operate the scraper on top of non-caving material. This allows the scraper to break down any high faces that may be standing.

Sauerman Storage Machines are built for hourly capacities of from 20 to 600 cu. yds. A partial list of producers and manufacturers using some type of Sauerman equipment includes:

Consumer Cooperative Assn.
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Lion Oil Co.
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For ways to reduce your material handling costs, write to Sauerman's experienced engineers. Request Catalog E, *Bulk Storage by Scraper*, plus field report 227, and other reports on the handling of your material by Sauerman Machines.

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Utah *(Continued)*

R. S. Archibald, president of North Range Mining Co., confirms his Upper Michigan iron ore concern has made agreements which could lead to option on the old Newhouse copper mine in Milford District, Beaver County.

The examination agreement signed with Norman Rogers Mining Co., Helena, Mont., calls for rehabilitation of a long tunnel on the properties. Ore grade when mining was suspended in the 1900's was above 2% copper.

Mr. Archibald said that if option were taken and exercised, mining would continue on an underground basis.

United Park City Mines Co. has established presence of mineralization in the important Wasatch limes of its Park City properties, S. K. Droubay, general manager, told recent annual stockholders' meeting.

The limes are between 800 and 900 ft below level of the Ontario Drain Tunnel and are the big hope of the future for mining in the district at depth.

Important, too, was establishment of the geological section.

One core taken showed ore. But the firm regards this only as "mineralization" or encouragement.

The ventures into the Wasatch limes is but one of a number of exploration programs listed in previous quarterly report of the company. All directors were reelected. Resignation of director Paul H. Hunt, Salt Lake City, who is on land and lease assignment in north Idaho district for Anaconda Co., was accepted.

Federal Uranium Co. shipped 2,680 tons of uranium ore during April, W. D. Nebeker Jr., president, reports at Salt Lake City.

Shipments do not include ore from subsidiary Rado Rock Resources Inc., for whom Hecla Mining Co. is mining at Randon properties in Big Indian District.

More than 4,000 tons ore were shipped in April from these properties, Mr. Nebeker said.

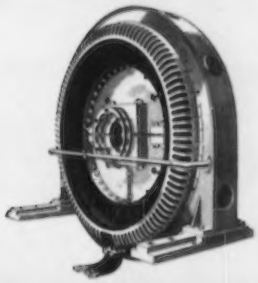
WASHINGTON

Newmont Mining Co. was the sole bidder on a key 120 acres of Spokane Indian Reservation land adjoining the Midnite Mine. The bid was $317,000 on Boyd Unit No. 1. Sources close to Newmont's subsidiary, Dawn Mining Co., which operates Midnite Mine, said the bid virtually assures construction of a proposed uranium processing mill near Spokane.

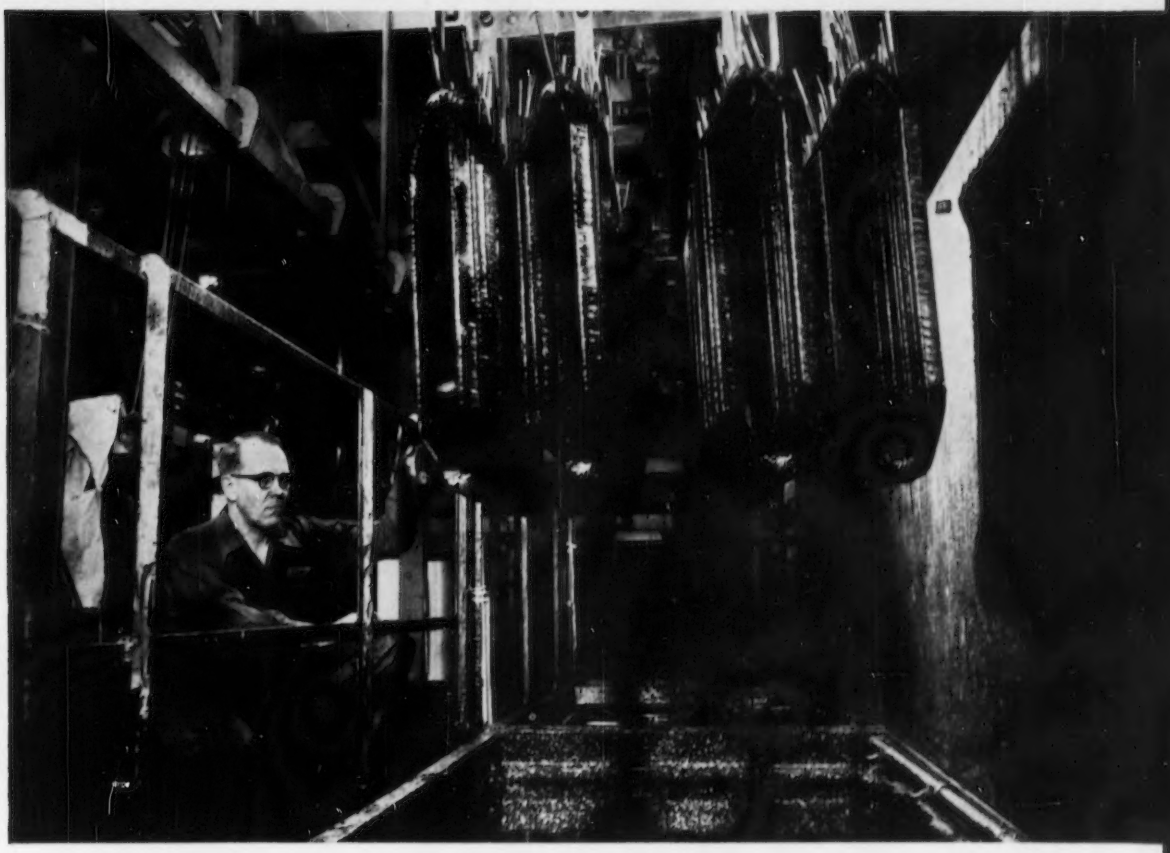
The 120 acres were considered important to continued operation of the Midnite Mine. Two diamond drill holes put down by the AEC in 1955 indicated the property contains a continuation of the Midnite orebody.

Three other tracts were open for bidding. Newmont bid $17,500 for Boyd Unit No. 2 of 120 acres, and L. V. Sigman, Yakima grocery chain owner, bid $750.

Newmont was the only bidder for



HOW G-E SYNCHRONOUS MOTORS
REDUCE MAINTENANCE COSTS



An insulating bath helps fight moisture

Moisture has the unhappy habit of working its way through motor coil insulation and reducing its capacity to withstand voltage stress. To guard against exasperating production-line shutdowns, General Electric seals coils with a coating of high-grade insulating resins. This seal is applied by a conveyor belt dip and bake system.

It works like this. After the main body of insulation is applied in the form of tapes and films of non-hygroscopic materials, each set of coils is placed on a conveyor and dipped in a bath of special, synthetic insulating materials. This way the coating is uniformly applied. Then the conveyor carries the coils into a huge oven and cures them for a specific length of time. The cycle is repeated until the proper seal is built up. Each step is automatically and precisely controlled—length of dipping and baking time and temperature.

This means the coils on your G-E synchronous motor are protected by a hard, tough insulation with high dielectric strength and high resistance to moisture and contaminants. Its glossy surface makes the coils easy to clean too.

All this adds up to less maintenance and down-time. For more information on G-E synchronous motors, contact your nearest General Electric Apparatus Sales Office or write Section 775-4 for Bulletin GEA-5332. General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

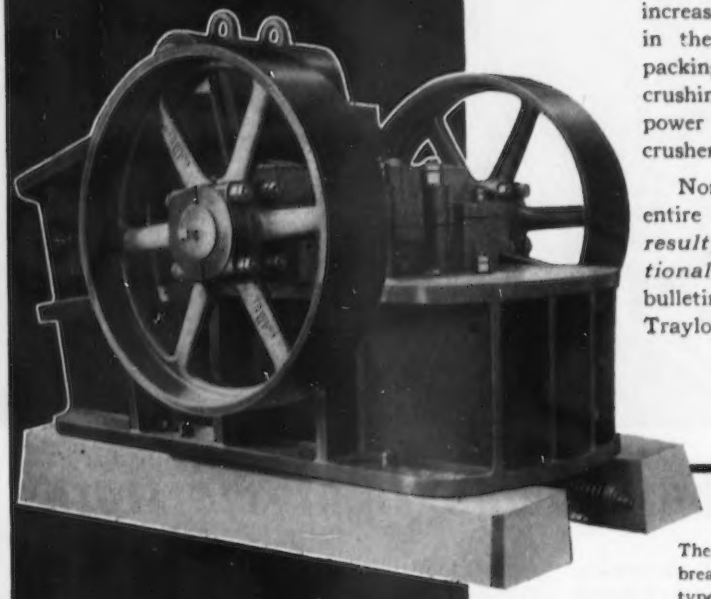
Traylor JAW CRUSHERS

MORE EFFICIENT REDUCTION OF ORE SHOWS UP IN HIGHER END PROFITS

Check with the leading ore producers and chances are you'll find their end profits start at a Traylor Jaw Crusher. For over half a century Traylor has been designing and building heavy-duty primary crushers that assure mining men greater hourly production with lower overall operating costs per ton produced.

Traylor original curved jaw plates apply power more efficiently as a direct crushing force. The increased capacity of each successive feeding zone in the crushing chamber reduces choking and packing. Because of more efficient application of crushing power, Traylor jaw crushers require less power per ton produced than any other jaw crushers.

Normal wear is evenly distributed over the entire face of Traylor curved jaw plates. *As a result, Traylor plates often outlast conventional plates by as much as 3 to 1.* Send for bulletin which outlines all the famous features of Traylor Jaw Crushers.



There's a Traylor Jaw Crusher to fit every primary breaking requirement. Traylor builds four different types, each in a wide variety of sizes. Feed openings range from 8" x 12" to 60" x 84"; capacities from 4 to 1000 tons per hour.

A Traylor leads to greater profits

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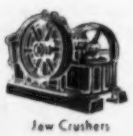
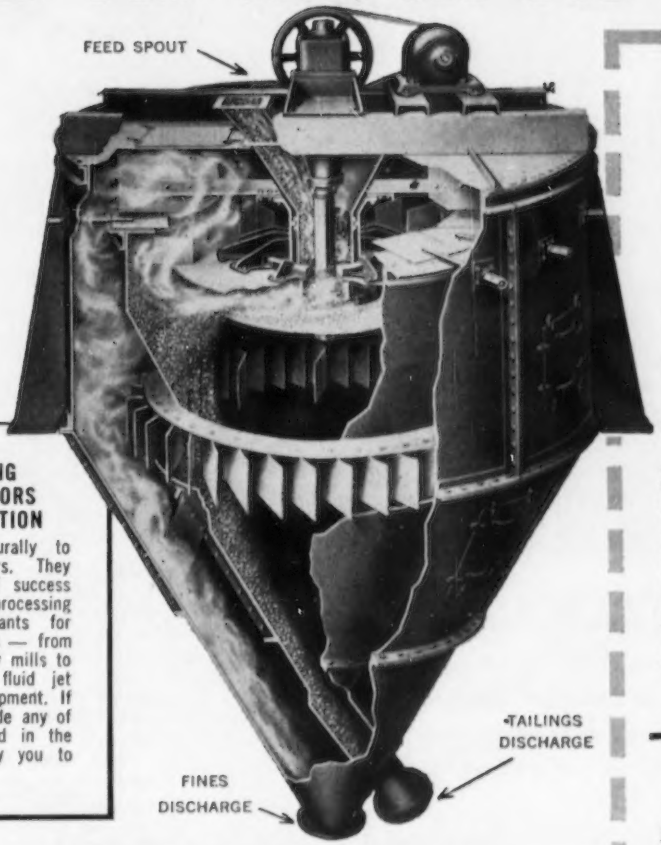
Ball Mills



Jaw Crushers

Secondary Gyratory Crushers

40 TO 400 MESH OUTPUT UPPED AS MUCH AS 300%



ENGINEERING AIR SEPARATORS TO SPECIFICATION

. . . comes naturally to Sturtevant engineers. They have a tradition of success in developing dry-processing equipment and plants for more than 75 years — from the first rock emery mills to the most modern fluid jet micron-grinding equipment. If your problems include any of the processes listed in the coupon, it will pay you to investigate.

WHAT CAN A STURTEVANT AIR SEPARATOR DO IN YOUR PULVERIZING SYSTEM?

In the cement industry, Sturtevant Air Separators have a tested record of increasing mill capacities from 25 to 300% while lowering power consumption as much as 50% — when used in closed circuit with grinding mills. Maybe they can do as well for you.

Easily adaptable to your materials. Sizes of Sturtevant Air Separators range from 3 to 18 feet in diameter. They deliver fines from 40 to 400 mesh at rates as high as 100 tons per hour.

Designed to cut costs! Sturtevant Air Separators are built for a lifetime of low-downtime service. Rugged construction plus easy accessibility for quick maintenance (typified by the "OPEN-DOOR" design in other Sturtevant equipment) assures more output per machine-year. Check the coupon for more information.

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The "OPEN-DOOR" to *lower* operating costs over *more* years

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* A rubber railroad that laughs at Winter

* In rugged "high country" famed for tough weather, a large western mining company wanted to move ore at an ultimate capacity of 2,000 tons per hour for a distance of nearly a mile and a gain in elevation of some 350 feet ...and maintain capacity in mid-winter as well as in summer.

Stearns-Roger designed and constructed a conveyor system that does the trick. Its 42" wide belt operating in four sections, is housed in a barrel-ceiling enclosure. This structure is fully insulated and is heated by electricity for efficient operation even when outside temperatures slide to minus 30° F.

Here again, Stearns-Roger has demonstrated its ability to employ basic methods of known efficiency and economy, and to adapt those methods to special operating conditions.

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Look to us for undivided responsibility in...
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Stearns-Roger Engineering Co., Ltd., Calgary

Washington *(Continued)*

Boyd units 3 and 4 of 114 and 104 acres, with an offer of $2500 each. Bids were all entered in the name of Dawn Mining Co., 51% owned by Newmont.

Germania Consolidated Mines, Inc., has resumed work at its tungsten mine near the Spokane Indian Reservation with improved weather. Henry Franz, managing director, said the overburden is being stripped from a new tungsten vein located last Fall. The firm has also undertaken exploratory drilling for uranium on leased land south of the reservation in northern Lincoln County.

Daybreak Uranium, Inc., has joined Yukon Oil, Ltd., in an operating agreement with Kit Carson Uranium, Inc., for more than 600 acres in the Mount Spokane district. The agreement nearly doubles Daybreak's operating properties in the area. Under the contract, Kit Carson Uranium receives one-third of net profits from ores on the property, one-third will cover lease costs, and the remaining third will be divided between Daybreak and Yukon.

Yukon holds 40 acres adjoining the property. Max Etter, Spokane attorney who is president of Kit Carson, said good mineralization has been encountered during drilling a half mile south of the Daybreak Mine.

Pend Oreille Mines & Metals Co. hopes to increase production by more development work. Jens Jensen, president, told stockholders at their annual meeting in Spokane that the company could process twice as much ore as it handled in 1955, and by so doing, increase its net income from $286,000 to approximately $860,000.

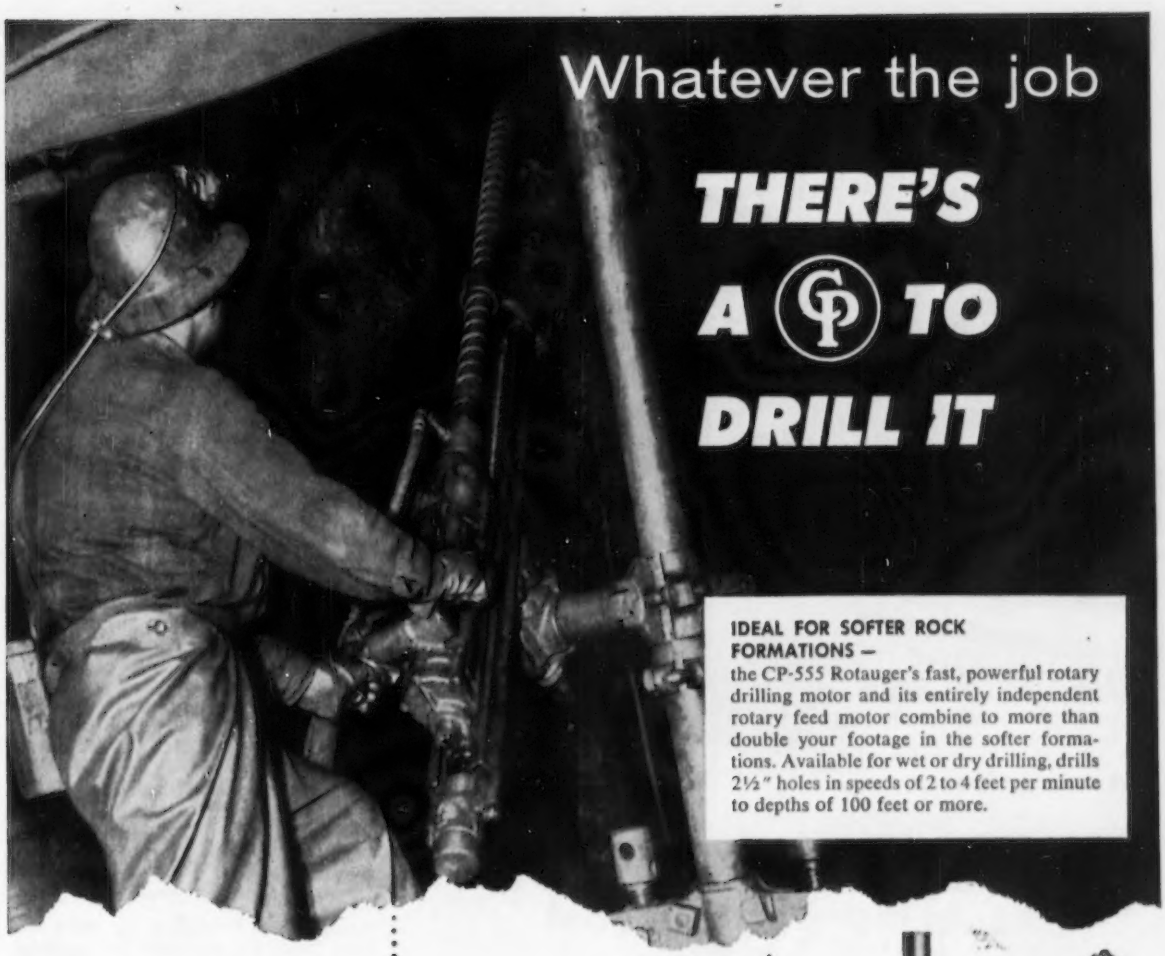
Mine output in the Metaline district operation for the first quarter of 1956 was boosted to 155,074 tons, compared to 130,886 tons a year ago. Jensen said the ore had a net smelter value of $4.76 per ton this year, compared to $4.74 in 1955.

Mining costs were $2.08 per ton during the first three months of 1956, compared to $1.86 in 1955, and output per man-shift declined from 18 to 15 tons. Jensen declared there is today little profit in mining zinc at present prices.

Northwest Uranium Mines, Inc., has discovered good widths of uranium ore in five of seven holes drilled on the Spokane Indian Reservation. D. L. Hetland, project geologist in charge of the AEC Northwest office in Spokane, said radiometric probes of three shallow holes in the eastern segment of the firm's property show a bedded deposit of commercial ore 16 to 27 ft thick.

Daybreak Uranium Inc., has been assigned the 160-acre Lowley lease on the Spokane Indian Reservation by William Lowley, lease holder, under whose name ore shipments will be started. The assignment must be approved by the Bureau of Indian Affairs.

Fourteen holes on the Lowley lease have shown good grades of uraninite and one hole showed uranophane ore. Other



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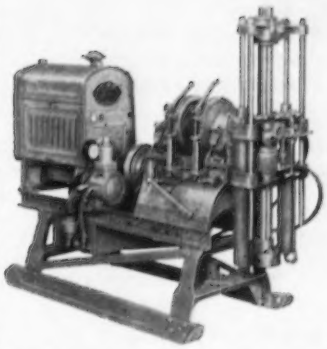
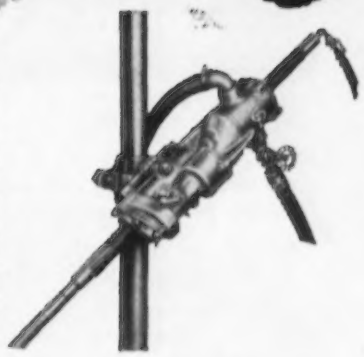
the CP-555 Rotauger's fast, powerful rotary drilling motor and its entirely independent rotary feed motor combine to more than double your footage in the softer formations. Available for wet or dry drilling, drills 2½" holes in speeds of 2 to 4 feet per minute to depths of 100 feet or more.

FOR FASTER SET-UPS—engineered to withstand constant recoil yet hold the drill firmly to the work, the CP Airleg affords the maximum drilling efficiency obtained when using Tungsten-Carbide bits. Available in integral types for production drilling and attachable types for conversion of standard sinkers to airleg operation. And in feed lengths of 36" to 48".



FOR EXPLORATORY DRILLING—CP Diamond Core Drills are available in air, electric, gasoline and Diesel Drives. Capacities to 2250 feet with E-EX Fittings. For skid, column, jeep or truck mounting.



FOR FASTER DRILLING—Designed both for blast hole and exploratory drilling, the air-driven CP-55A Diamond Core Drill has the most powerful vane-type air motor built into a diamond drill. Conservatively rated at 500 feet with E Rods and EX Fittings.

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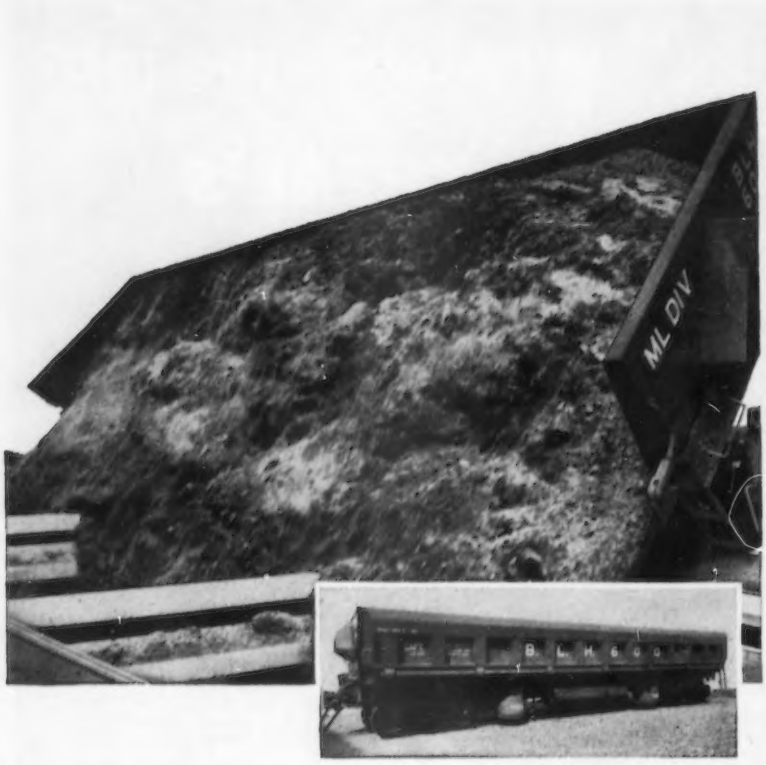

new 60-yard Western dump car hauls more at less cost

Built of alloy steel, with all welded frame, this new car combines rugged strength with minimum dead weight. And here are some design features you ought to know about:

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- Double plate, curved top door is universally recognized strongest dump car door.
- Low center of gravity assures stability at all times. Does not sway when under way.
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Washington *(Continued)*

drillings failed to locate commercial grade ore. Two carloads have been stockpiled and the company plans to pile 30 to 40 before shipping. Vitro Uranium Corporation, Salt Lake, previously had agreed to buy Daybreak ores from the reservation.

WEST VIRGINIA

Cerro de Pasco Corp. has acquired control of Fairmont Aluminum Co., of Fairmont, which ranks as the largest independent non-integrated producer of aluminum sheet, coil and circles in the United States. Announcement of the acquisition was made by Robert P. Koenig, Cerro de Pasco president.

WYOMING

A record-breaking 84 truckloads of uranium ore were received in one day at the Riverton AEC buying station.

Five producers in the Gas Hills area of central Wyoming delivered full quotas during April, a record tonnage month. They were Vitro Minerals Corp., Globe Mining Co., Valley Dean, Lucky Mc and Two States.

Gas Hills producers delivered 95% of the April tonnage. Other ore was delivered from the Pryor Mountain area, over the Montana border, Little Mountain near Lovell, Copper Mountain area, Crooks Gap and Pumpkin Buttes.

Amrad Oil & Minerals Corp., Salt Lake City, Utah, has purchased 199 uranium claims in the Gas Hills area of Fremont County. Purchase Price was $25,000 and 157,600 shares of stock, par valued at $78,800.

Sellers included numerous Lander and Hudson, Wyo., residents. Principal owner was Alfred Ellerby, Lander. Each reserved an 8% royalty.

Included in the sale were 192 Backer claims, 94 Pilot claims, and three Reesie claims. Most claims are located on the top of Beaver Rim. Some are located on the slope.

Ellerby said a testing and development program will be started soon. He reported deep drilling will be required on a large portion of the property to test an ancient stream channel.

President of Vipont Mining Co., Lander, Alfred Ellerby, announced his firm negotiated a mining lease agreement on 4,480 acres of deeded land on the Wind River Indian reservation. The transaction was the first major uranium development on the reservation.

The lease was negotiated with Walter Knollenberg of Crowheart. The land lies in the northwest corner of the reservation. Ellerby said Vipont will launch a large-scale prospecting and drilling program in the area.

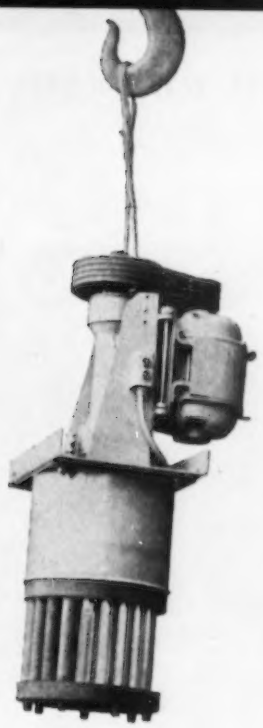
The reservation, covering about 2-million acres, was recently opened to uranium prospecting. No permits have been issued yet on tribal land.

ONE DEAD CELL

but this

WEMCO Fagergren

still produces



There is no down time when a Wemco Fagergren mechanism is lifted out for service. The bank of cells continues to produce without interruption. Sanding up of the inactive cell is no problem. When the serviced unit (or a spare) is returned, it simply digs its way back into position.

Over half the world's flotation tonnage is produced in Wemco Fagergrens. Operating convenience and easy maintenance are among the reasons both large and small plants choose these machines. High recovery and low reagent consumption are other deciding factors.

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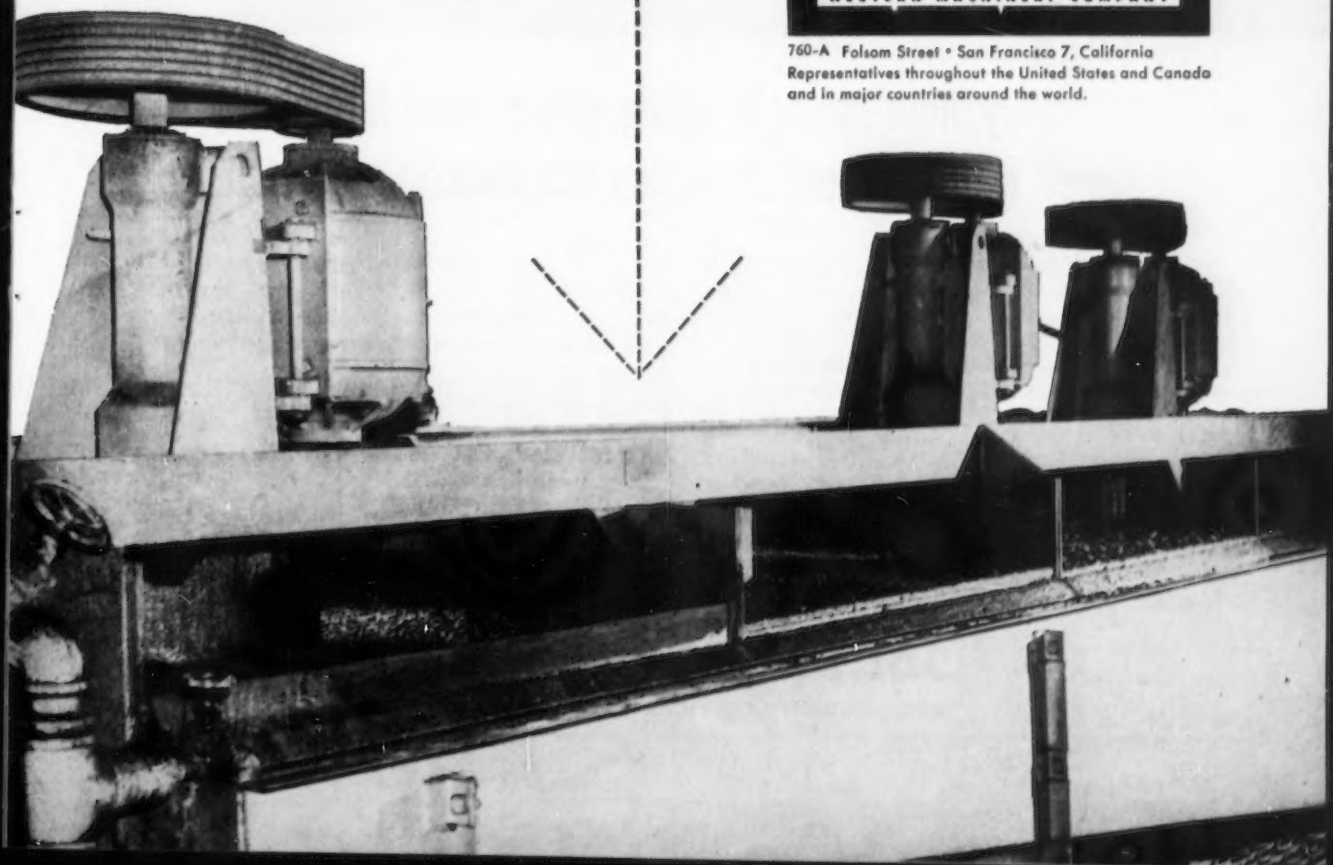

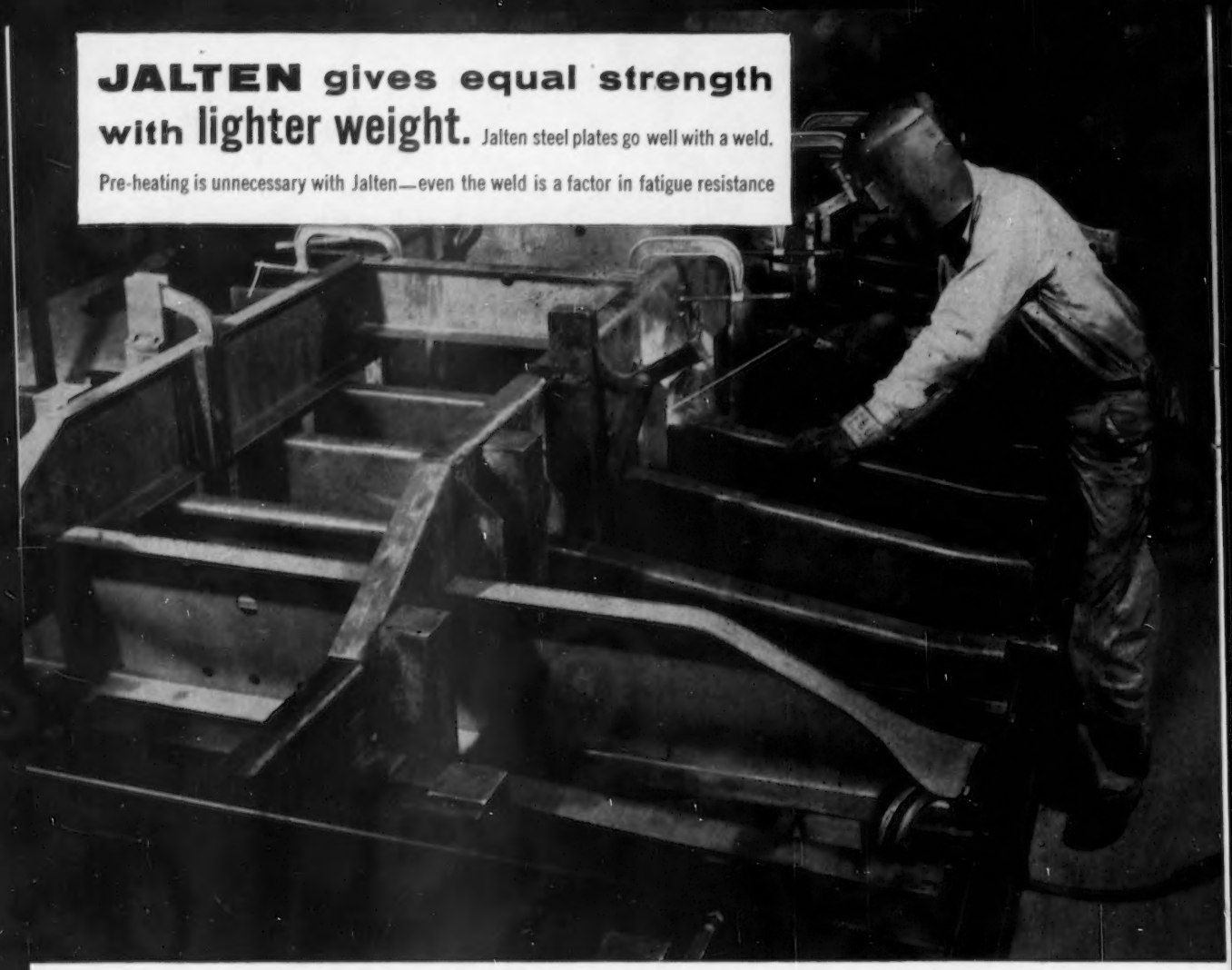

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Low alloy, high strength Jalten offers good formability coupled with excellent corrosion and abrasion resistance

Jalten's high strength permits high design loads. It also permits a reduction in section when used to replace mild steels. Usually the reduction amounts to two gages affording a weight savings of approximately 25 per cent. Thus, dead weight can be eliminated—resulting in increased carrying capacity. Also, it is easily welded.

Jalten is furnished in four grades:

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No. 3—gives high strength—improved resistance to abrasion.

No. 4—provides superior formability and surface quality for bumper stock applications requiring plating.

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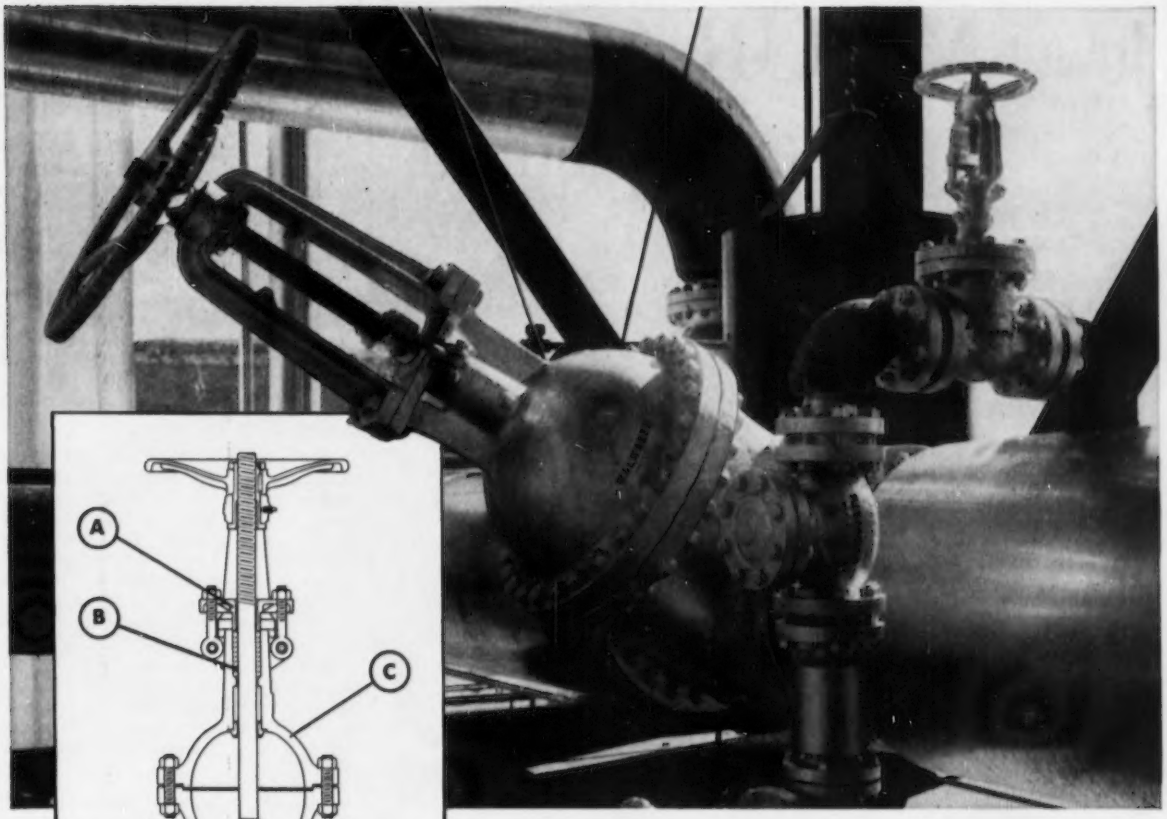

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IN CANADA

ONTARIO

Algoma Ore Properties Ltd., wholly-owned subsidiary of Algoma Steel Corp., is understood to be preparing for another major expansion program at its Michipicoten iron properties. Plans involve boost in high grade iron sinter output by some 350,000 tons to 1,770,000 tons annually, and the opening of a new mine at Siderite Hill, 3½ miles east of the company's Helen mine. At the Helen mine preparations are also being made for the development of a deep ore block, estimated to contain some 50-million tons of iron ore.

Indications are that several new special price contracts for uranium concentrates will be granted to companies in the Blind River and Bancroft areas. In the Blind River camp, Spanish American, Panel Consolidated, Lake Nordic, Milliken Lake, Stanleigh Uranium, and Stancan Uranium, and in the Bancroft area, Dyno Mines, appear to be assured of production contracts. Mill capacities for these companies are anticipated as follows: Spanish American 2,000 tpd; Panel Consolidated 3,000; Lake Nordic 4,000; Milliken Lake 3,000; Stanleigh Uranium 3,000; Stancan Uranium 3,000; and Dyno 900.

Consolidated Denison Mines is well ahead of schedule on mine development and plant construction at its large uranium property in the Blind River area. The No. 1, or service shaft, has been bottomed, while the main production shaft is down below 700 ft. Treatment plant is scheduled to start at half-capacity on Jan. 2, 1957, with the second unit coming into production early the same year. Capacity production, 5,700 tpd, is expected to be reached by the summer of 1957. The company has a $182,250,000 contract from Eldorado Mining and Refining Ltd. for sale of its uranium concentrates.

Diamond drilling at the large copper-nickel prospect of Temagami Mining Co. in the Temagami Lake area during the past season has resulted in expansion of both indicated and probable ore reserves. Decision has been made to erect a 2,000 tpd mill, which is double the rate previously planned. Current estimates place ore reserves in excess of 5-million tons, and it is anticipated that this figure will be increased as development and further exploration proceed.

Norpax Oils and Mines has commenced crosscutting at the 250-ft level, following completion of a 275-ft exploratory shaft on its nickel-copper prospect in the Werner Lake area, 55 miles northwest of Kenora. Some 600 ft of drifting along the ore zone, followed by diamond drilling and shaft sinking to 400 ft, is planned. Surface diamond drilling, prior to present work, had indicated over 1-million tons of ore to 500-ft depth.

Contract for construction of a 1,000 tpd

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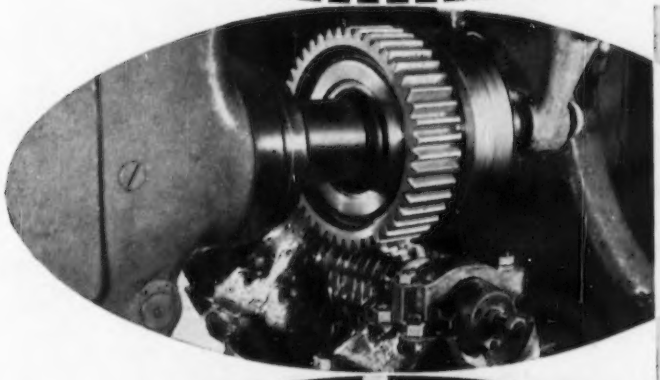

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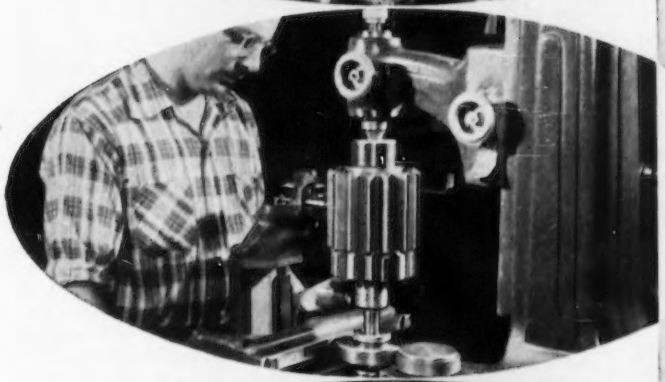

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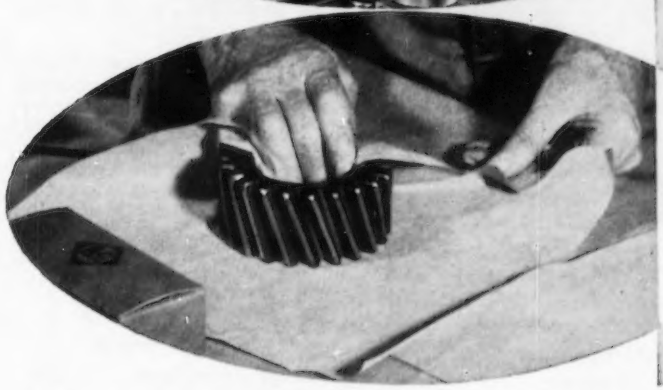

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Ontario (Continued)

mill has been let by Coldstream Copper Mines for its Kashabowie area copper prospect, 80 miles west of the Lakehead. Under the present schedule, first production of copper concentrates is anticipated by September 1957. Fill-in diamond drilling, which will permit revision of tonnage-grade estimated, is being carried out. Meanwhile shaft deepening to open a 4th level at 575 ft is being completed. Following development of the 4th level, sinking will be resumed to 1,000-ft depth.

Nickel Rim Mines, nickel shipper in the Sudbury Basin area, is planning to increase mill capacity from the current 730 to about 1,000 tpd by the end of the year, and to 1,500 tpd by June 1957. Shaft deepening is proceeding and its completion will provide two additional levels for a total of seven levels. Ore reserves at March 1, 1956, above the third, or 550-ft level, have been estimated at 900,891 tons averaging 0.74% nickel and 0.32% copper. In addition 636,000 tons have been indicated by diamond drilling along a length of 200 ft to vertical depth of 500 ft below the third level.

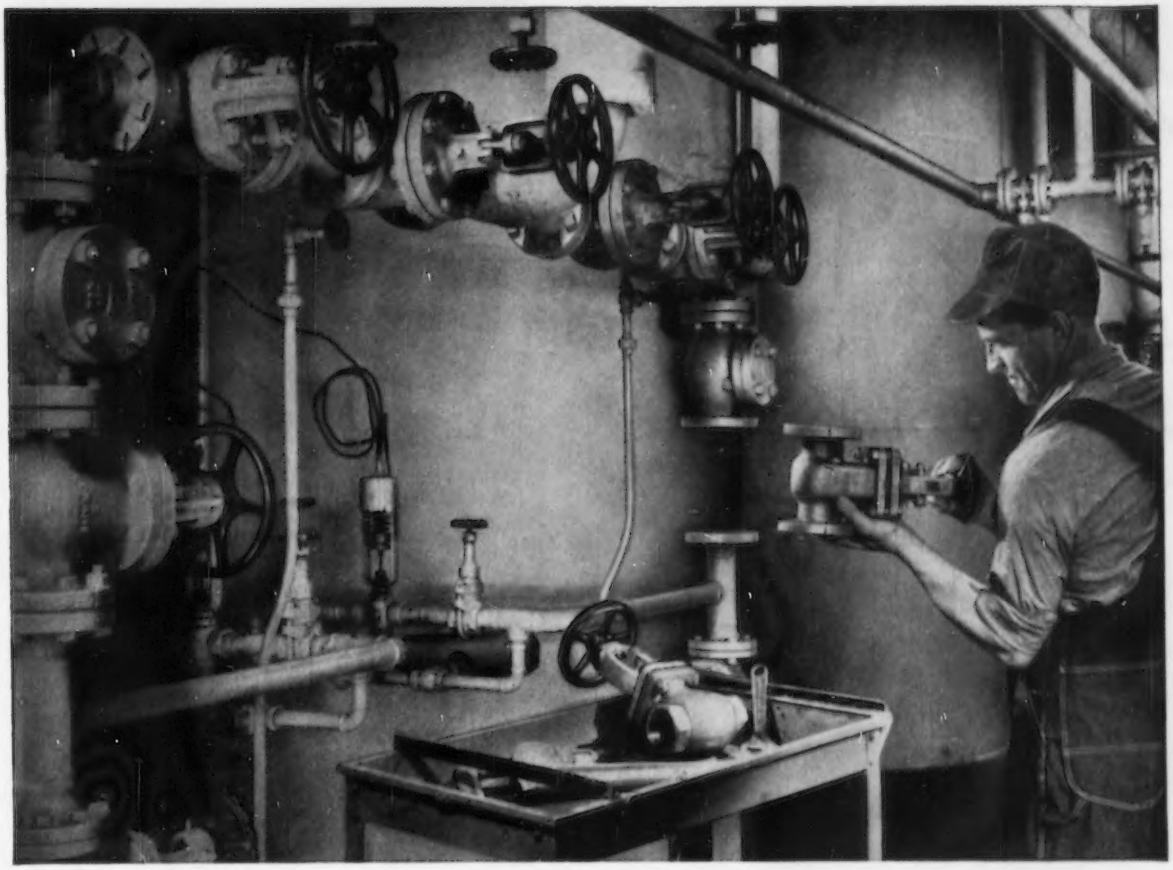
A $500,000 contract for construction of a unique headframe for the production shaft at its base metal property in the Manitouwadge area has been let by Geco Mines. The huge headframe of concrete construction will be 50 ft square and tower 240 ft above the shaft collar. All hoisting equipment and motors, as distinct from the conventional installation, will be housed in the top of the headframe. The job is expected to be completed by the end of the current year.

Stancan Uranium Corp. is making good progress in shaft sinking at its Quirke Lake uranium property in the Blind River area. The main production shaft is to go to a vertical depth of 3500 ft, while the service shaft, 1,000 ft to the north, will be bottomed at 2700 ft. Preparations for design and construction of a treatment plant and for design and equipping of the mine for production are now presently under way.

A surface exploration program, including intensive diamond drilling, is to get under way on the large copper prospect of New Minda Scotia Mines in the Temagami area. Test channeling and pitting along a contact zone, traced for 1.25 miles across the property, gave promising values in copper. Drill stations are to be spotted along this contact following a geophysical survey.

QUEBEC

Quebec Copper Corp. is preparing to increase the mill rate at its copper producer in Brome Twp, Eastern Townships, from 800 to 1,000 tpd. Officials estimate there is sufficient ore indicated to date to support operations at the higher tonnage for 5-6 years. Larger hoisting facilities are being installed and a new production shaft is to be put down.



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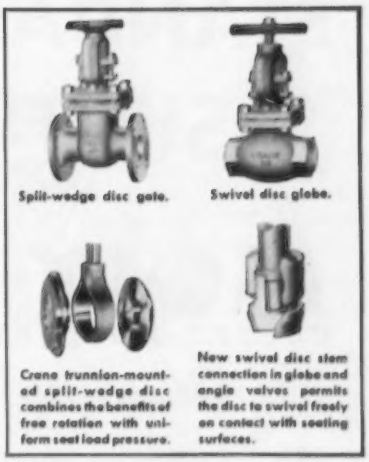

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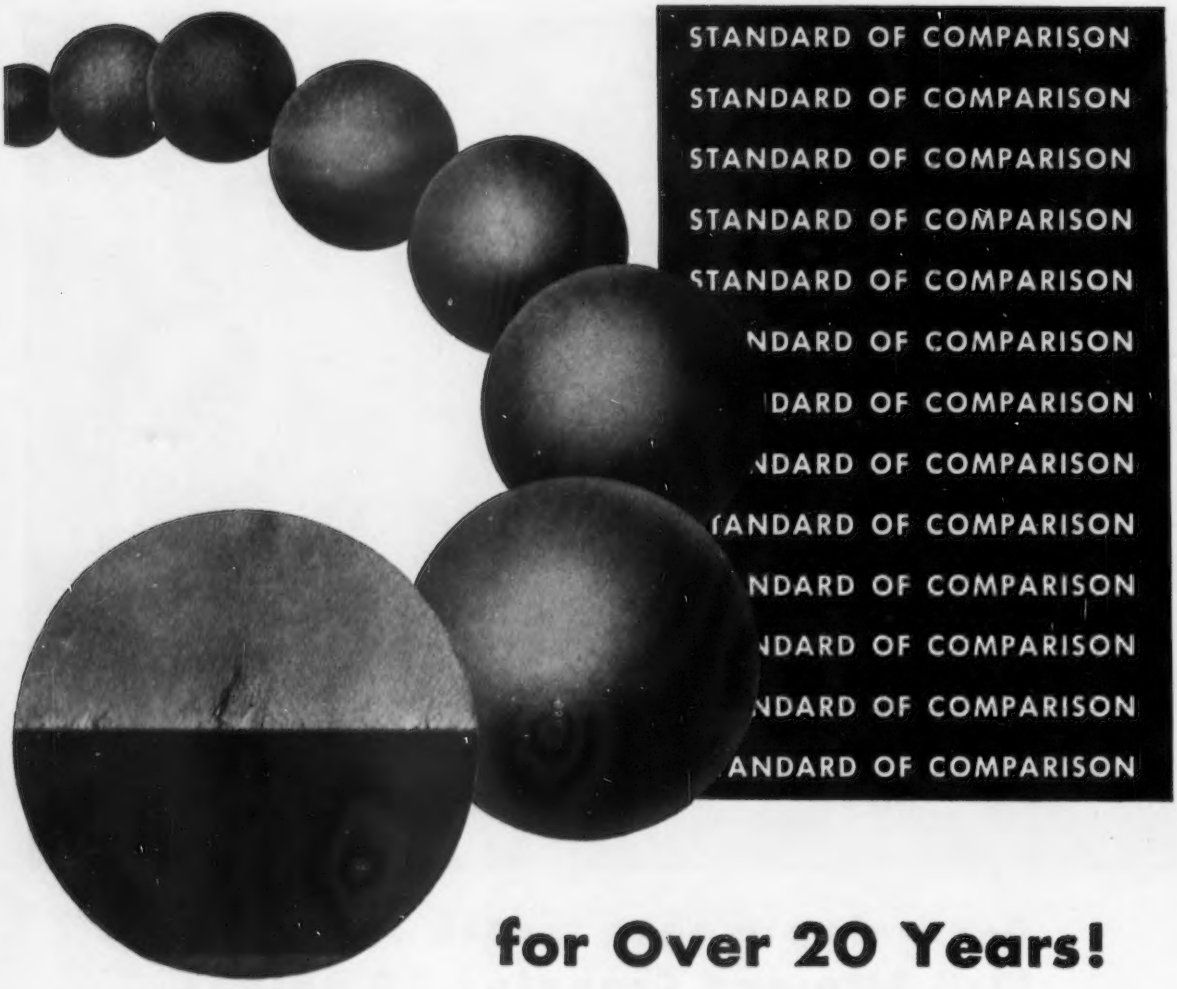

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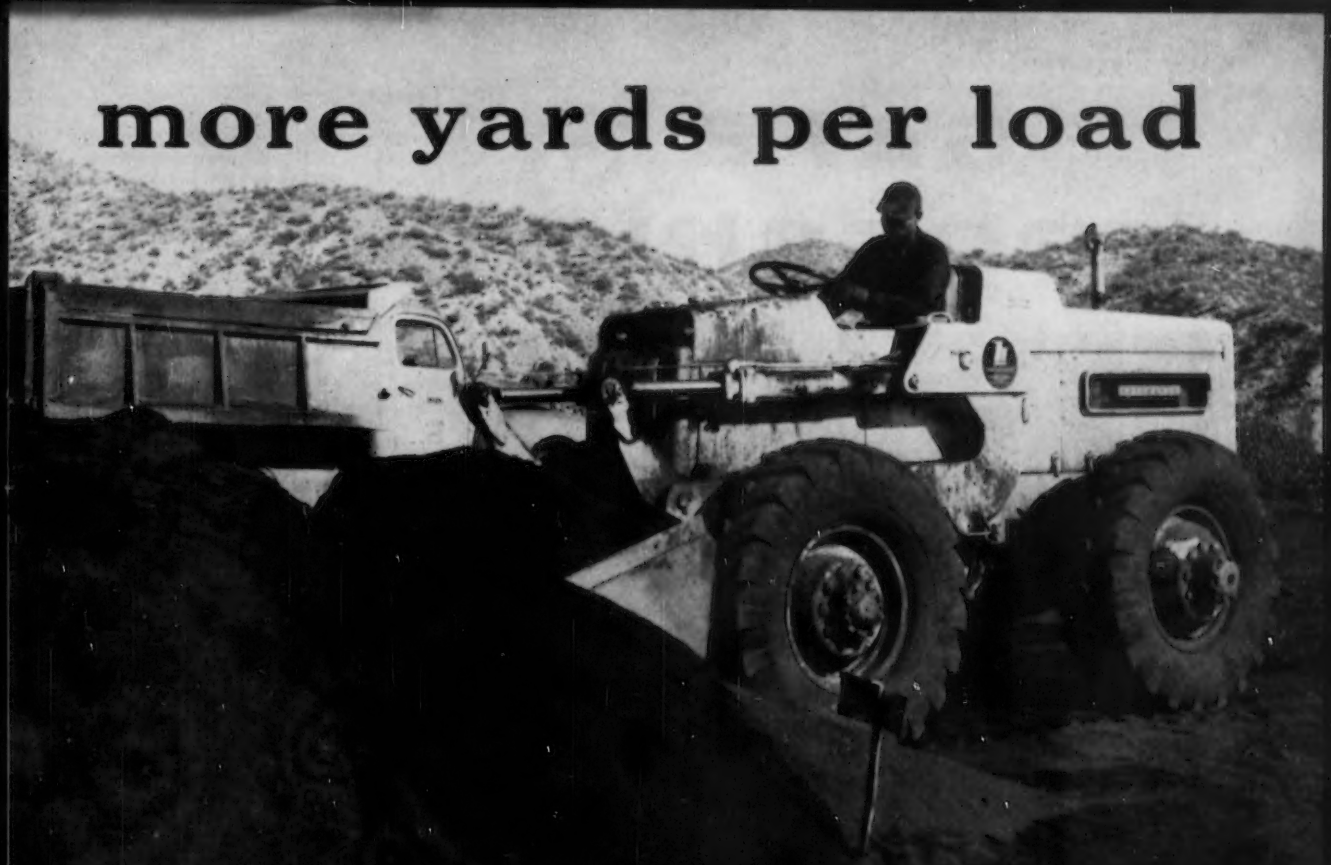

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Quebec *(Continued)*

Quebec Lithium Corp., Canada's first and only producer of lithia concentrates, is moving steadily toward full capacity production of 1,000 tpd. Underground work at the mine, located some 25 miles north of Val d'Or, has developed a substantial ore picture with indications of 15-million tons to depth of 500 ft in a radius of 600 ft around the shaft. The company holds a 5-year contract for Lithium Corp. of America for lithia concentrates, and is currently preparing to recover feldspar and quartz concentrates for other markets.

Merrill Island Mining Corp. is making excellent progress in deepening the shaft on its copper prospect in the Chibougamau area. Mining plant has been installed and headframe strengthened. Objective of current sinking is 1,000 ft. In work several years ago, two levels were established at 150 and 300 ft. Lateral work on these levels and surface diamond drilling at that time had indicated an estimated 705,978 tons averaging about 2.7% copper and 0.015 oz gold per ton. Recent diamond drilling has expanded ore potential substantially.

Recent diamond drilling on the Perry zone at the copper producing property of Opemiska Copper Mines in the Chibougamau area has expanded ore potential. The zone, which lies to the east of the main mine workings, has been indicated for a length of 1,060 ft averaging 4.66% copper across an average width of 10.7 ft. This is estimated as equivalent to about 1,000 tons per vertical foot based on drill intersections from 200 to 700 ft in depth. A second ore zone has been indicated to the west and this is also being investigated.

Initial performance at Chibougamau Explorers, Anacon Lead Mines' new copper-gold producer in the Chibougamau district, had stood up to expectations. Grade has measured up to initial estimates and production is being maintained at satisfactory level. Recently underground work and diamond drilling have indicated new important ore measures in the new north zone, located some 200 ft from the main shear. Work on the zone is being continued.

Duvan Copper Co. is preparing to deepen the shaft on its copper prospect in Desmeloizes Twp. to open up an additional four levels at 100-ft intervals below the present bottom level at 450 ft. Recent work on the latter has indicated greater widths than anticipated and a program of exploratory deep diamond drilling is to be carried out.

Eastern Mining and Smelting Corp. is concentrating on preparations for production at its Chicoutimi operation. Plans call for full scale operations at the mine and concentrator by Oct. 31, 1957, and at the smelter by Dec. 1, 1957 Power plant, now in the construction stage, is scheduled for operation by Apr. 1, 1957. Initial output is expected to run at 15-million lb of nickel metal and 100-million lb copper annually. Ore will be de-

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Quebec *(Continued)*

rived from properties owned by the company or controlled by Mogul Mining Corp.

Coulee Lead and Zinc Mines and Headway Red Lake Gold Mines are carrying out further diamond drilling on their jointly owned Oka area property, 35 miles west of Montreal. Two drill rigs are in operation to test continuity of zones outlined in previous work. The latter had indicated some 15-million tons grading 0.39% colubium, 0.02% uranium, 0.01% thorium, 5.7% apatite, and 0.3% rare earths in one section. New zones have been indicated in current work.

A substantial tonnage of good grade ore has been indicated by diamond drilling carried out in the past several months in the south zone at the copper prospect of New Jaculet Mines in the Chibougamau district. Five drill rigs are now in operation with three more being added. An intensive drilling program is now in progress to determine suitable shaft site.

Shaft deepening at the copper-nickel property of Eastern Metals Corp., 65 miles southeast of Quebec City, is currently in progress to open three additional levels at 150-ft intervals below the present bottom of fifth level at 750 ft. Plans are to provide for mill feed of 300 tpd with possible expansion to 500 tpd. Ore reserves to 750-ft depth are estimated at 466,770 tons averaging 1.26% copper and 0.15% nickel, and 402,330 tons averaging 0.95% nickel.

New Delhi Mines has started diamond drilling on its base metal property in Clericy Twp., 10 miles northeast of Noranda. The drilling is designed to test several anomalies indicated by geophysical survey recently completed. Earlier drilling returned widely disseminated low copper values.

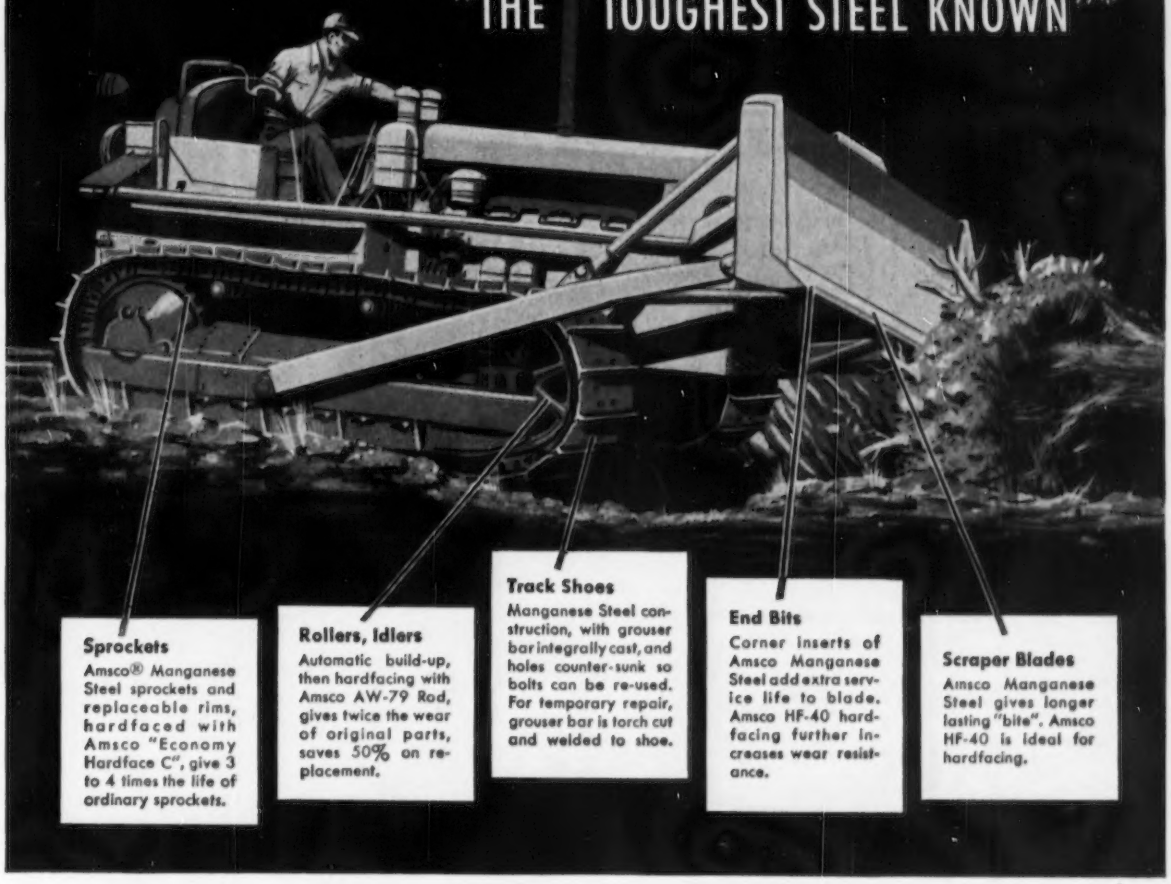
Beattie-Duquesne Mines is preparing its mill at its gold property near Duparquet to handle flotation of copper ores. It is expected that this operation will get under way early this July. The shaft at the Hunter copper property, some 3½ miles northeast of the mill, has been sunk to 460 ft with third level station cut at 450 ft. This property is expected to produce 500 tons of copper ore daily.

MANITOBA

Combined Developments has outlined 5,869,000 tons grading 1.205% lithium oxide on its Herb Lake property. Company has received results from flotation tests carried out on bulk samples, which indicate the deposit is amenable to known spodumene beneficiation processes.

Lithium Corporation of Canada, controlled by Mogul Mining Corp., reports shaft sinking will commence soon on its Irgon property at Cat Lake. Headframe, hoist and compressor installation are completed and the 14-mile power line

At these TOUGH WEAR points, specify "THE TOUGHEST STEEL KNOWN"*



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Amsco® Manganese Steel sprockets and replaceable rims, hardfaced with Amsco "Economy Hardface C", give 3 to 4 times the life of ordinary sprockets.

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Automatic build-up, then hardfacing with Amsco AW-79 Rod, gives twice the wear of original parts, saves 50% on replacement.

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Manganese Steel construction, with grouser bar integrally cast, and holes counter-sunk so bolts can be re-used. For temporary repair, grouser bar is torch cut and welded to shoe.

End Bits
Corner inserts of Amsco Manganese Steel add extra service life to blade. Amsco HF-40 hardfacing further increases wear resistance.

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Amsco Manganese Steel gives longer lasting "bite". Amsco HF-40 is ideal for hardfacing.

*AMSCO MANGANESE STEEL . . . plus AMSCO HARDFACING

Shown above are just a few of the "tough wear" points where Amsco products can save you money. Whether for original parts, or for build-up and hardfacing, specify Amsco Manganese Steel and Amsco Hardfacing for maximum operating economy.

We'll be glad to give you full information on Amsco Tractor Parts, Hardfacing Materials or Automatic Welding Machines. Just call your nearby Amsco representative, or write us direct.

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DIGGING: backhoe buckets—dippers and parts—repointers—dragline bucket parts—dragline chain—sheaves—pinions.

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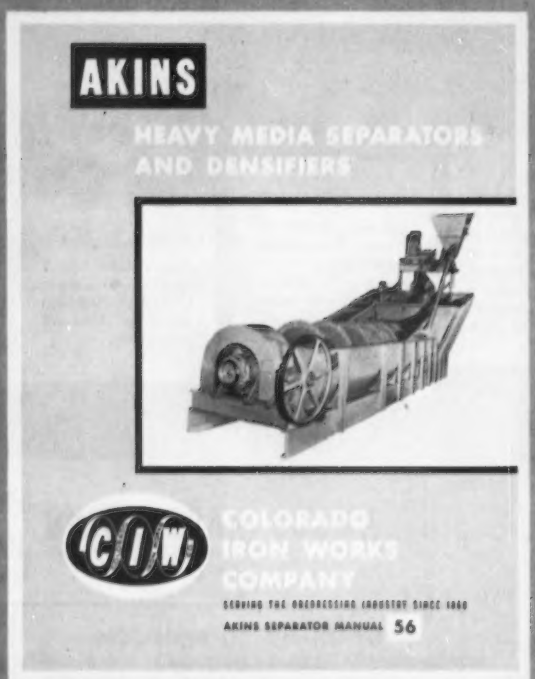
Experimentation on use of the Akins Spiral Classifier in making a sink and float separation was first started in 1938. In 1944 the first commercial 78" Akins Separator was placed in successful operation by one of the large iron mining companies. Since then there have been many developments and refinements, mechanically and metallurgically, in the Akins Separator and the HMS process. This new manual is a complete presentation of these developments and includes the latest data on heavy media spiral separators and densifiers...



- development of spiral HMS separators
- discussion of metallurgical and mechanical operation of spiral separators
- handling of middlings
- how the Akins makes a 3-product separation with one medium circuit
- operating data showing actual results
- purpose of the densifier and how it works
- flowsheets
- capacities and engineering data on Akins Separators and Densifiers
- operating and control instructions

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CIW has a 12" Akins Separator at the Colorado School of Mines Research Foundation which is available for conducting pilot tests.

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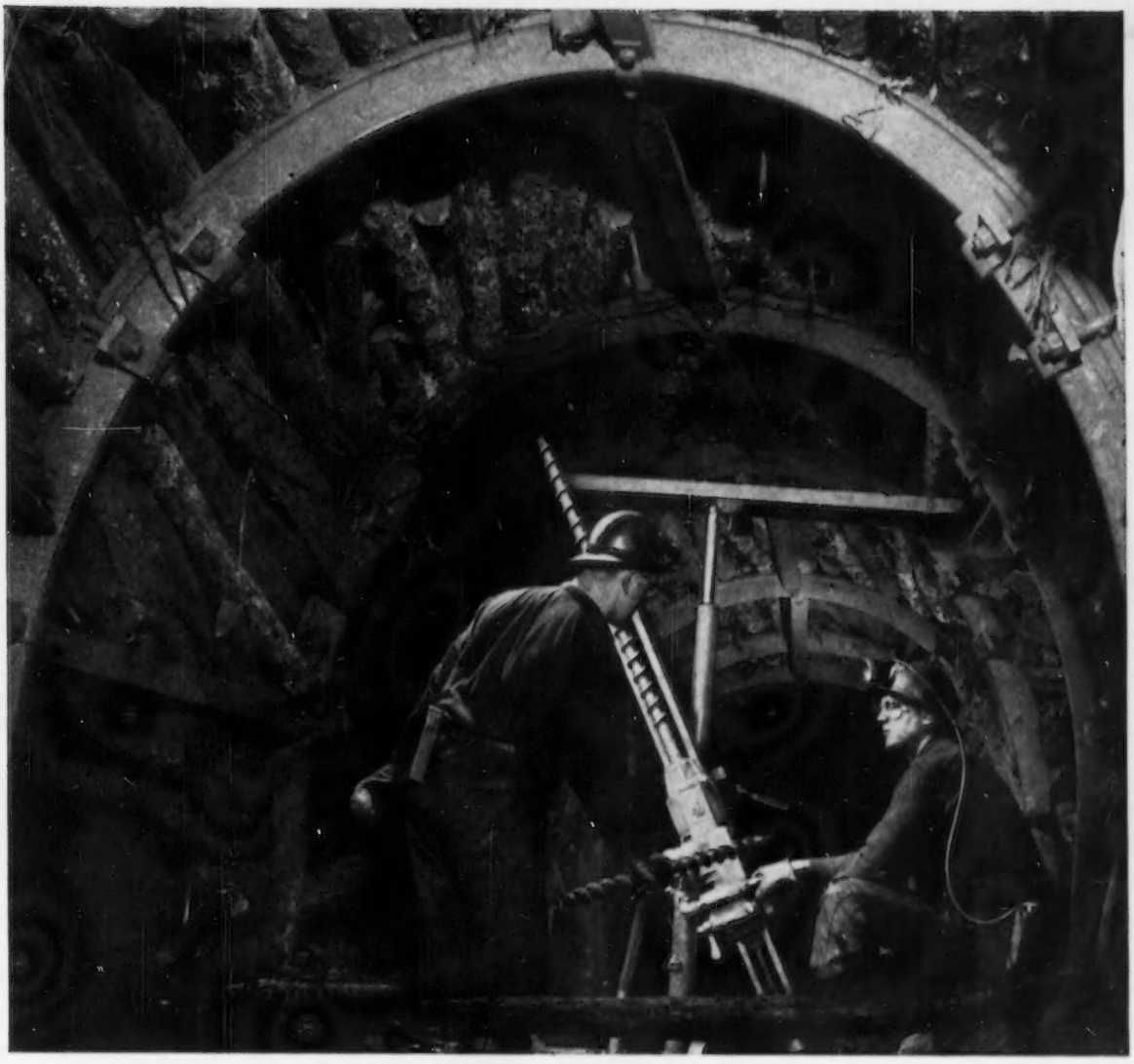

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The CP-555 Rotauger is short in length but long on performance. It combines a fast, powerful rotary drill with an independent rotary motor feed to put the operator in full control at all times. Sets up quickly in tight quarters. Available for dry or wet drilling. Drills up to 3 inch holes more than 100 feet deep at 2 to 4 feet per minute in gypsum, talc, medium limestones and other softer formations. More information is available by writing Chicago Pneumatic Tool Company, 8 East 44th St., New York 17, N. Y.

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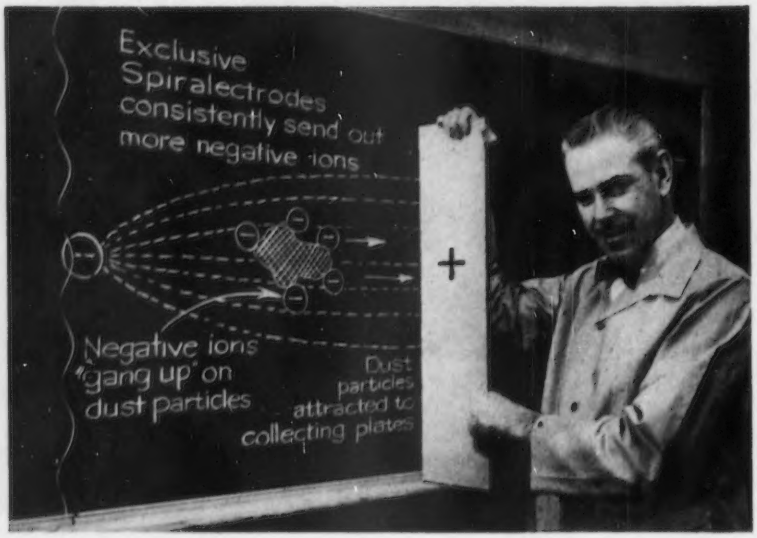
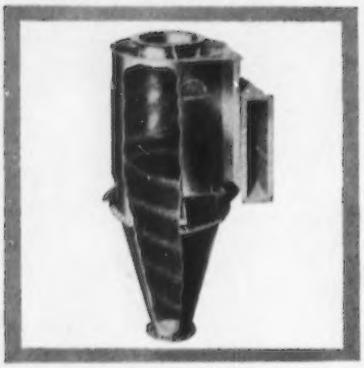
How a Buell Collection System "gangs-up" on dust to meet the toughest air pollution codes





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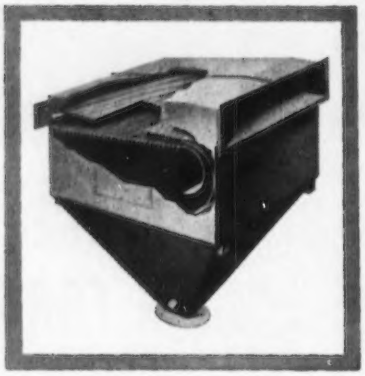

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DUST COLLECTION SYSTEMS

Manitoba *(Continued)*

has been erected. Plans are to develop the 200-ft level prior to completing the shaft sinking to a depth of 640 ft. Diamond drilling is to be resumed on the company's Bernic Lake lithium prospect where winter drilling gave good results. Company holds 196 claims in the Winnipeg River-Cat Lake area and plan active prospecting during the summer field season.

Hudson Bay Mining & Smelting has announced discovery of base metal occurrences in the Snow Lake area considered to be of major importance. Limited work to date has disclosed commercial quantities of zinc, copper, gold and silver but no estimate can be made of tonnage. The area under intensive exploration and development lies approximately 70 miles east of Flin Flon. The company has acquired over 3000 claims.

New Manitoba Gold Mines reports 1.2 million tons of low grade copper-nickel ore on its Cat Lake property. Detailed drilling is being carried out to outline the margins of the ore. A shaft site is being prepared and company expected to have the shaft collared by the end of June.

Amanda Mines reports a detailed exploration program will get under way on two groups totalling 87 claims acquired in the Snow Lake area.

Northern Canada Mines has acquired an interest in 186 claims in the Snow Lake area in the vicinity of recent base metal discoveries. Other companies participating with Northern Canada are Pioneer Gold Mines, Tern Lake Mines and Cuney Lake Mines. Some exploration work was carried out at Woosey Lake during the winter.

Aumaque Gold Mines reports a series of narrow veins carrying gold and base metal values has been indicated by diamond drilling on its Lynn Lake property. Drilling will be stepped out to explore other areas on the property for possible nickel-copper sulphide zones. Geophysical work will also be carried out.

Montgary Explorations and its subsidiary, Surpass Petrochemicals, report they have acquired the chemical plant of Alox Corp. in Niagara Falls, N. Y. At present Montgary is negotiating with U. S. interests to bring its Bernic Lake lithium property into production. Over 5.6-million tons of ore averaging 1.7% lithium oxide were outlined by drilling during the winter months. The deepening of former drill holes is now in progress. The presence of three parallel sills has been confirmed in the No. 1 hole.

BRITISH COLUMBIA

Interest in Highland Valley Copper properties has been boosted again this month by news of what is believed to be a major copper discovery about 18 miles south of the original activity.

Highland Valley Mining Corp. Ltd.,

Michigan Model 175A owned by E. J. Petrillo, Inc., sold and serviced by United Tractor and Equipment Corp., N. Y. C.

On the New York Thruway

This 2¼-yd. Michigan loads out 6-ton oversize blast rock

This photograph shows a section of E. J. Petrillo's contract on the New York Thruway where the contract called for removal of an old granite quarry. Petrillo used one of his 2¼-yd. Michigan Tractor Shovels to load out oversize blast rock. Some of the rock weighed as much as 6½ tons and measured close to 8 ft. wide.

Substitute for 4-yd. crawler

Superintendent Tony Tangredi said that the job normally would have called for a 4-yd. crawler-loader, but the crawler-loader wasn't available. So he decided to try the Michigan, even though he considered this an unusually tough assignment for a rubber-tired machine. During the three weeks the Michigan was on this job, its performance was satisfactory in every way.

Note the size of the stones being loaded into the rear-dump.

Speed on the job

Petrillo's Michigans are always on the move—loading trucks in the borrow pit, handling general clean-up work all over the job. "A big advantage to us is the maneuverability of these Michigans", says Supt. Tangredi. "At 27 mph, they get where they're needed in a hurry —and you don't need trailers to move them. On this rock-handling job, we proved that the Michigans will handle the tough assignments along with the routine jobs."

Handles the tough jobs

Like E. J. Petrillo, Inc., more and more owners have found that a Michigan will handle jobs which have always been considered too tough for rubber-tired Tractor Shovels. The exclusive Clark power-train — torque converter, power-shift transmission and planetary wheel drive axles—gives the Michigan more useable power and traction than you've ever seen on this type of machine. Your Michigan distributor would like the chance to prove it. Ask him to demonstrate on one of *your* tough jobs —you name it.

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Construction Machinery Division
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CLARK® EQUIPMENT

British Columbia *(Continued)*

announced the find and heavy staking is under way in the area. The company is preparing to diamond drill.

Located at Gordon Lake, midway between Spences Bridge and Merritt, the deposit is reported to be of a type rare in Canada, but the same as that from some of the largest copper mines in United States, including those at Butte, Mont., and are being mined to depths of 3,000 ft and deeper.

Foundation Mines Ltd., on the Hope-Princeton Highway, will start diamond drilling a nickelferous pyrrohite deposit on their 16-claim base metals property, 120 miles east of Vancouver.

Now in the third year of operation, Foundation plans a stepped-up exploration program and consulting geologist Alfred R. Allen also recommends a magnometer survey and surface trenching.

Queen Charlotte Islands have been the scene of a new wave of copper-staking activity. Center of attraction is on the southeast coast of Moresby Island, about 400 miles north of Vancouver.

St. Eugene Mining Corp. is the principal interest involved and although first reports indicated staking activity of rush proportions, a spokesman for St. Eugene said that the movement was not to be classed as a large scale operation.

St. Eugene is controlled by Frobisher-Ventures organization.

Tungsten of British Columbia has outlined an immediate diamond drilling program for their copper-lead-zinc-silver property that could be the spearhead of a new exploration and development drive in the north central part of the province.

Tungsten property, near the northern B.C. town of Usk on the main Canadian National Railways line to Prince Rupert, is reported to have shown six mineral occurrences, which include:

Grotto gold-silver veins, Lead vein, Central Copper, North Canyon Copper and South Canyon Copper, A and B (or Upper) Copper.

A $25-million potash development is being planned by a Vancouver syndicate for Melville in Saskatchewan, about 75 miles northeast of Regina.

Robert Campbell, a British Columbia industrialist, who heads R. Campbell and Associates, earlier announced plans for a $60-million pulp mill in the Prince Albert area of Saskatchewan also.

Campbell said potash withdrawl rights had been obtained for 300,000 acres stretching 50 miles northwest from Melville to Ituna and Kelliber.

SASKATCHEWAN

La Ronge area, 85 miles north of Prince Albert is getting set for its biggest year of copper exploration and mining notwithstanding recent price declines.

The La Ronge area was the scene of intensive exploration activity in 1955. More than 3,000 claims were staked before winter closed in and many operators carried out diamond drilling during the coldest months.

This summer, with access up to 35 miles northwest of La Ronge being made possible by government road as well as by barge, there are good indications that staking activity will exceed the 1955 figure.

Heavy claim staking is being recorded in the Drinking-Keg-Trade lakes and Forbes Laroque areas about 60 miles east and northeast of La Ronge. A 15-mile mineral belt has already been defined by surface exploration.

There are signs that exploration is extending even further eastward, in the direction of the new discovery mines of Hudson Bay Mining and Smelting Co. recently announced in the Coronation and Birch Lake areas just inside the Saskatchewan boundary near Flin Flon. Chalcopyrite is the main copper-bearing mineral throughout this entire region.

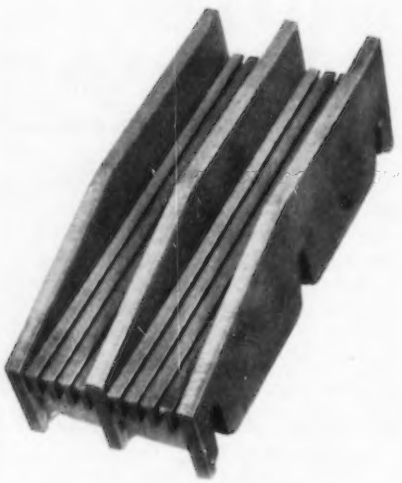
Biggest and most active company in the La Ronge area is Anglo-Rouyn Mines, with an indicated 3-million tons of 1.97% copper ore to a depth of 500 ft on its Moose Point property off Waden Bay.

Anglo-Rouyn is now going ahead with shaft sinking according to schedule. A second shaft section has been completed to the 280-ft level and the shaft is down to 340 ft., the objective being 500 ft. Equipment for lateral development has

just what the "doctor" ordered . . . *for heavy loads of metal mining!*

Any mining "specialist" will tell you there's nothing like this Hendrick Wedge-Slot C-12 Screen with mounted skid bars for heavy duty metal mining.

The rugged skid bars protect the wedge-slot profiles from the large ore chunks. The C-12 profile bars have thick parallel head flanges to maintain uniformity of openings until the entire head is worn down. Designed for tops in heavy duty service and excellent drainage quality, C-12 bars are 12/64 of an inch wide . . . slots run the whole length of the screen. Write for details.



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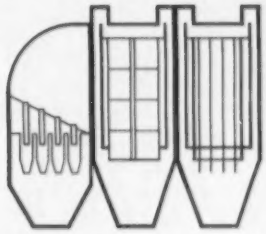
■ Almost a half-century ago—in 1907 to be exact—Western Precipitation installed the first commercial application of the now-famous Cottrell Electrical Precipitator—and has more know-how, more varied experience and application background in world-wide installations in this type of equipment than any other organization, domestic or foreign.

■ Many years ago Western Precipitation was first again with the multiple small-diameter tube type of cyclonic collector—the type with higher centrifugal forces for greater recovery efficiencies. And through the years, Western Precipitation engineers have continuously led in new advancements, new refinements in the *mechanical* recovery field as well as in *electrical* recovery methods.



■ Western Precipitation was the first to combine Electrical and Mechanical recovery advantages in one compact, coordinated system—the CMP (Combination Multiclone—Precipitator) Unit. This equipment, offering almost constant collection efficiency despite varying gas volume, requires years of experience in both electrical and mechanical recovery methods for proper operating "balance".

. . . only Western Precipitation has had such extensive experience in basic recovery methods!

These are only a few of the many important reasons why a Western Precipitation installation is recognized as the best obtainable. This unequalled know-how is quickly available throughout the major industrial areas of the United States and Canada from strategically-located, fully-staffed offices and field representatives, as shown at right. There's one as near as your telephone.

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1. LOADERS distribute Du Pont Delay Electric Blasting Caps in 42-hole drift round prior to loading at the Crescent Mine of the Bunker Hill Co. at Kellogg, Idaho.

2. FACE ready for shot. Load is Du Pont "Gelex" #1 (1⅛ x 8), primed with Du Pont MS and regular Delay Caps—a winning combination for effective blasting.

3. BLASTER fires the shot with a Du Pont CD-32 Blasting Machine. This lightweight machine eliminates the necessity of maintaining permanent firing lines . . . yet can fire up to 480 caps in parallel series.

4. RESULT of the blast—excellent breakage, which speeds loading. Good fumes of "Gelex" get the scalers and muckers back quickly. Try the dependable line of Du Pont mining products in your operations!

You can enjoy the same excellent fragmentation and on-schedule operations by using Du Pont Explosive and Blasting Supplies in your mine. Your Du Pont representative will be glad to go into further detail. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

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SINKING FRAMES
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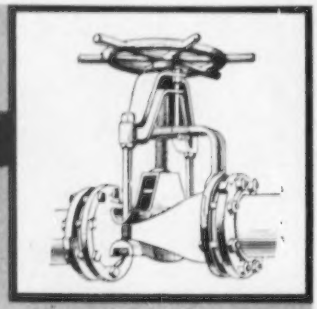
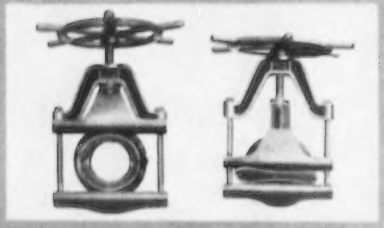


now available with lighter-duty sleeves

The 3, 4, 5, 6 and 8 inch sizes are now available with rubber sleeves for pressures up to 50 lbs. per sq. in., for lighter-duty service. Where applications do not require the standard 150 lb. pressure sleeves, these have the advantage of lower cost and easier operation. They are interchangeable with the 150 lb. sleeves.



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Recesses molded into opposite sides of the sleeve serve as "hinges" during compression. This patented feature prevents undue strain and eliminates breakage and excessive wear due to valve adjustments.

Advantages...

- Long life under severe conditions
- Unobstructed flow passage
- Positive closure on solids
- No working parts in contact with pulps or liquids
- No packing glands
- Minimum friction loss
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- Cannot leak or stick
- Resistance to oils
- Resistance of the special rubber sleeve to abrasion and corrosion is greater than that of the metallic interior parts of gate valves or plug valves.
- Only ONE wearing part
- Withstands all chemicals not harmful to rubber or neoprene
- Withstands temperatures to 180° F.
- Freezing temperatures are not harmful.

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SIZES:
1", 2", 3", 4", 5",
6", 8", 10", 12", 14"

Saskatchewan *(Continued)*

arrived and this phase will begin upon completion of the shaft work.

Other companies interested and active include Madsen Red Lake Gold Mines, which has a 26-claim copper group just east of the Anglo-Rouyn properties. The company is carrying out a geophysical survey and has announced its intention to proceed with diamond drilling.

International Nickel, through its exploration subsidiary, Canadian Nickel, has an exploration program getting under way at Forbes Lake. Others already active or waiting for all ice to clear from the lakes are Kelkeno Copper, the Saskatchewan company which initiated much of the pioneer exploration in the area; Forbes Lake Mining Corp.; Selco Exploration, a subsidiary of the Selection Trust Co. of London; Newmont Mining Corp.; Glenn Uranium; Pioneer Contractors; Consolidated Regcourt Mines; Tombill Mines; and Precam Exploration.

Record expansion of uranium mining and exploration activity in the Beaverlodge area this summer is foreseen in the 80% increases in volume of business Northern Transportation Ltd. predicts it will chalk up from its northern Saskatchewan operations before freeze-up.

Demand for transport services this year is also extending eastward from the Lake Athabaska area with unconfirmed reports of new mining finds 150 miles away by a British mining company.

Anglo Barrington Mines, a Canadian subsidiary of Western Selection and Development Co. of London, has announced a uranium discovery which may open up an entirely new area of Saskatchewan for development.

Anglo Barrington said it made the discovery just before ice break up the middle of May, in diamond drilling on an 89-claim group at Higginson Lake. Area is 142 miles east of Uranium City.

Gunnar Mines, although not permitted to divulge precise gross tonnages, has revealed that April production at its Beaverlodge properties reached $1,282,000 compared with $1.25-million in March. Working now on a three-year tax-exemption company's milling rate has reached a capacity of 1,450 tpd, with expansion planned for 1,650 tpd by November.

King Copper Mining Corp. is planning diamond drilling at its uranium prospect along Soulier Lake 17 miles north of Uranium City. The drill is to test further a radioactive zone traced for length of more than 1500 ft by surface work. The company reports good values from channel sampling.

Exploration work has resumed on the property of Uranium Ridge Mines at the southwest end of Beaverlodge Lake. The company, in which Chimo Gold Mines and Violamac Mines Ltd. have substantial interests, has stated that the crosscut is being pushed from the first level of Lorado Mines immediately to the east, toward two surface drill holes put down by Uranium Ridge. One of the drill holes returned an intersection of 6.0 ft of 0.11% uranium oxide, and the second, 210 ft away, returned 3.0 ft of 0.37%.

SELECTIVE MINING A PROBLEM?

This 4½-yard Marion dragline makes a good "prospector" in mining where irregular deposits require selective digging. With the 111-M, you get the "no-clutch-heat" advantages of electric swing, whether the machine has diesel or Ward-Leonard electric equipment. Its fast cycle time, travel speed, and long, wide crawlers help it to turn in a big day's work, every day.

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There's a reason! They're lightweight, yet designed and built to stand-up under the most rugged conditions. Your choice of power plant and mounting on trailer or small truck.

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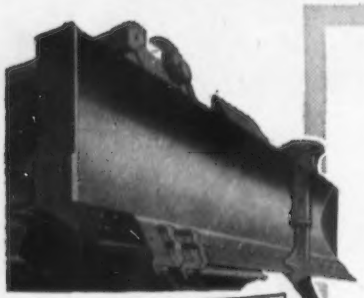

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IN LATIN AMERICA

CHILE

During last March Braden broke its milling record, treating during that month 1,056,771 short tons which works out at a daily average of 34,089 short tons with a peak tonnage on March 4 of 35,710 tons, an alltime record.

These records were possible on account of the expansion and improvements in the mill which were carried out during 1955 and finished in January of this year. In the crushing section, 10 new Symons crushers have replaced 8 old type crushers which were in service for over 30 years. In the grinding section, 4 primary mills and 2 classifiers and 8 secondary mills and 4 classifiers have been installed. The classifiers are of the latest type by Dorr-Oliver.

The flotation section will be completely overhauled and modernized. Braden was the first mill on the Continent to replace gravity concentration by flotation.

Present cells will be replaced in stages by Fagergren cells. In the first stage, eight banks of old machines having each a capacity of 950 tpd will be replaced by 10 banks of Fagergren machines with a capacity of 1300 tpd each.

Braden is building at La Junta two 26,000-cubic ft reinforced concrete tanks where the sewage from the Sewell townsite will be treated and about 75% of the water it contains will be saved. The water thus recovered will be pumped back to the mill head tanks in stages.

Braden Copper Co. has also broken another record in Chile. Its principal camp, Sewell, where the mill and head offices are located, has the lowest infant death rate in the country.

The government plans to build the new copper smelter and the electrolytic refinery at the port of Quintero, just north of Valparaiso. This smelter will reduce all concentrates and ores from Ovalle south while Paipote will smelt the output from the town of Ovalle to the north.

Government also plans to increase Paipote's capacity so as to avoid having to export low grade ores which the Mining Bank must buy from the miners and which Paipote cannot smelt with its present capacity.

Andes Copper Mining Co. won in 1955, for the seventh successive year, the C. F. Kelly Safety Award which is given each year by Anaconda Mining Co. to that of its affiliates or subsidiaries with the lowest accident rate. Though its accident rate in 1954 was already very low, Andes was able to better it in 1955 by 59.8%.

Harry Guggenheim, chairman of the board of the Anglo-Lautaro Nitrate Co. which owns the two largest nitrate mines and plants in Chile, Pedro de Valdivia and Maria Elena, expressed satisfaction at the passing by Congress and becoming a Chilean law, the Nitrate Referendum approved by the nitrate companies and

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Third, Flexible rubber impact idlers absorb shock of falling materials, thus reducing cutting and wear of belt.

Fourth, Specially-designed self-aligning troughing idlers, in addition to forward tilt of regular idlers, hold belt in line.

Fifth, New-type self-cleaning rubber return idlers virtually eliminate build-up of abrasive materials on roller.

Sixth, Rollers and idlers turn easily. Anti-friction bearings are used throughout. This also cuts power requirement.

Needs fewer support towers

Another outstanding feature of PIONEER Conveyors is their extra strength and rigidity. Angle iron construction, welded vertical and diagonal braces, and upper and lower chords tied together with lattice-frame construction make it possible to space support points as far apart as 40 feet.

It's easy to assemble PIONEER conveyors because no section is over 10′ in length. Head and tail sections are specially built to meet your H.P. requirements.

TONS PER HOUR DELIVERED BY PIONEER CONVEYORS*

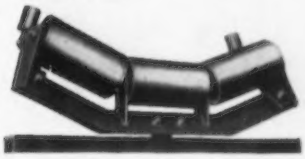
Belt Width	Belt speed in feet per minute			Maximum lump size	
	300′	400′	500′	Sized	Unsized
18″	156	—	—	4″	6″
24″	276	368	—	6″	8″
30″	432	576	720	7″	12″
36″	624	832	1040	8″	16″

*Based on material weighing 2700 lbs. per cubic yard.

PIONEER Mesabi-type impact idler

PIONEER Rubber roll self-cleaning return idler.

PIONEER Self-aligning troughing idler



Ask your conveyor salesman these questions

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2. Are they located on through shafts?
3. How many support towers will be necessary?
4. What's the approximate cost of assembling and erecting?

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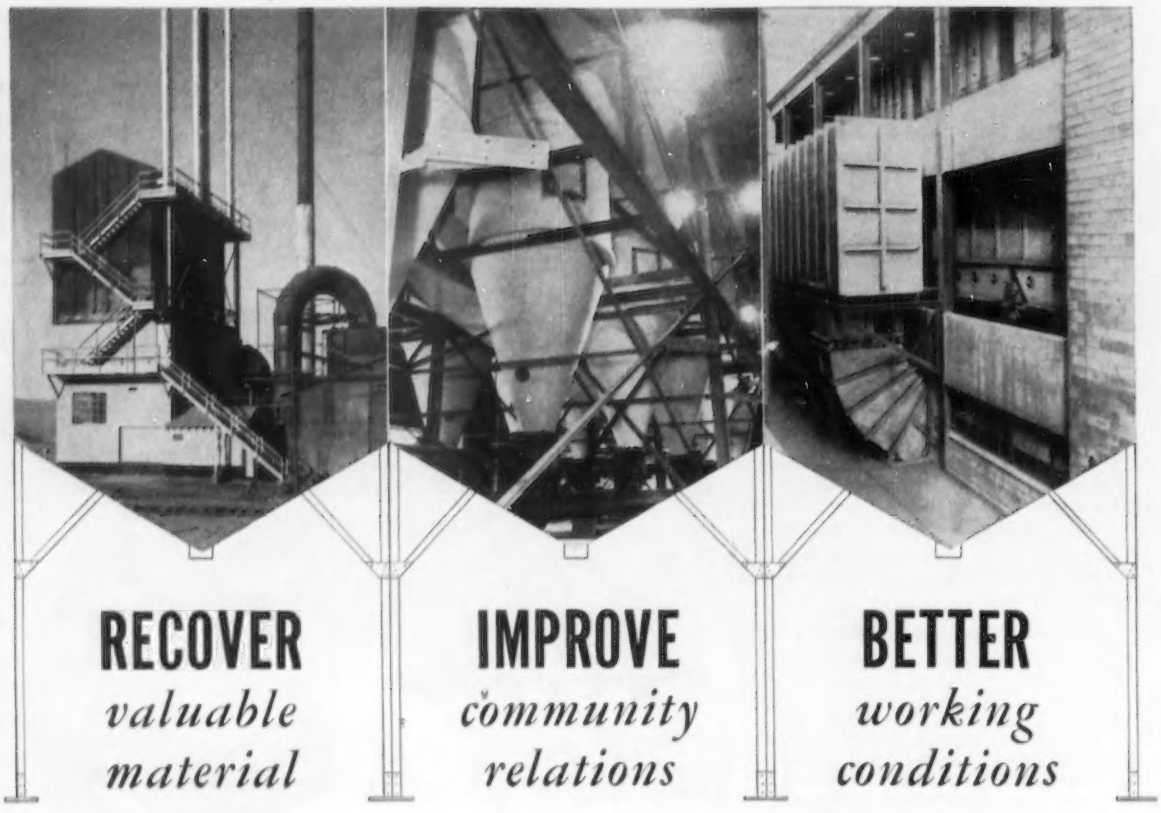

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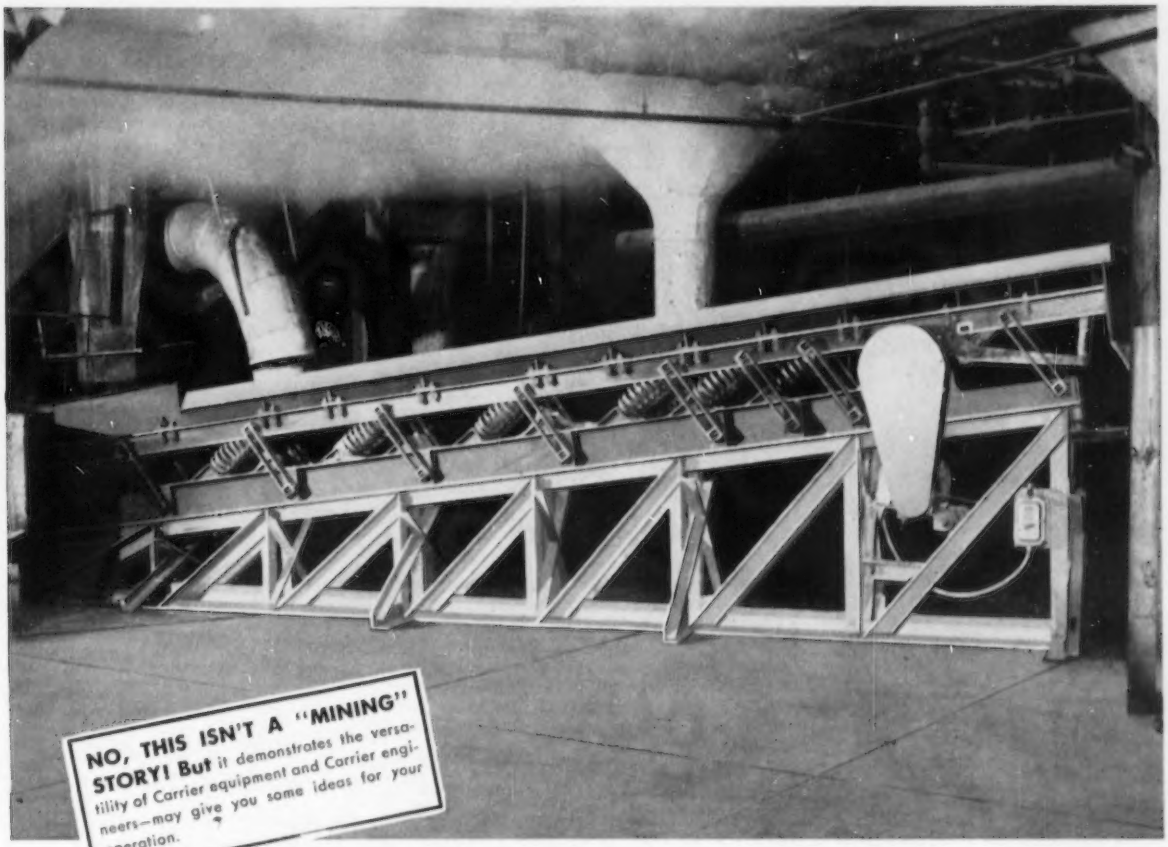
NO, THIS ISN'T A "MINING" STORY! But it demonstrates the versatility of Carrier equipment and Carrier engineers—may give you some ideas for your operation.

Magic! — broken glass becomes duck soup!

YOU can't see it—but broken and molten glass is being moved to storage on that Carrier Natural-Frequency Conveyor in Corning's Wellsboro Plant. The broken glass (called cullet) used to be collected in metal tote boxes, doused with water, then taken to storage with a fork-lift truck.

Excess man power was involved in the operation—three men were used in non-productive capacities to move the tote boxes. A tremendous amount of water was consumed by the process, and steam from the molten glass and water caused corrosion problems that were not easily dealt with. Steam and water overflow also made large areas of the sub-basement untenable.

Cleaning up this operation was obviously no job for a boy. But for Carrier engineers it was almost routine. Working with the manufacturer, they soon designed a series of Natural-Frequency Conveyors to take on the whole dirty job, *automatically and continuously!*

The molten and broken glass is now fed directly onto Carrier Conveyors. Pools of water—plus vibration—combine to size, quench, cool and dry the material, *while it is being conveyed.* No man-power, no fork-lift truck, no mess. What's more, the pans are covered so that steam is exhausted outside the plant, and water costs are running $25 less per day!

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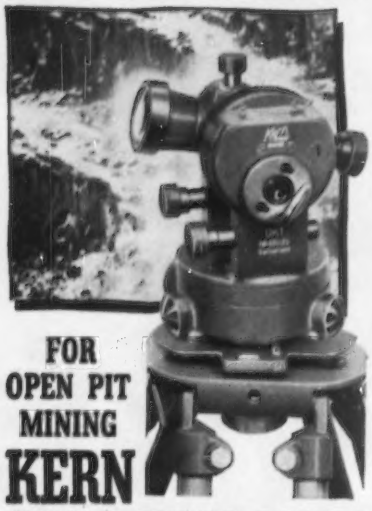

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Chile *(Continued)*

the government and which will give the natural nitrogen fertilizer a new lease on life in its losing fight against the synthetic competitors. Mr. Guggenheim hopes to be able to obtain an appreciable loan from the ExImbank which will permit its plants to improve mining and beneficiation methods, go thoroughly into research and build a mechanized loading port at Tocopilla which will cut loading time for a ship from 10 days to one day.

That the nitrate industry is in need of real help is shown by the fact that its share of nitrogen fertilizer compounds produced in the world has decreased from 65% to 4%. In the U.S. the number of synthetic nitrogen plants has increased from 19 in 1951 to 35 in 1954 and it is expected that there will be 52 plants operating by 1957. Chile produces an average of 1.5-million metric tons of sodium nitrate per year, one-third of which is sold in the U.S. at a higher price than the synthetic compounds, while in 1957 the U.S. will be producing the equivalent of 25-million tons of sodium nitrate.

PERU

Development of the Acari iron ore deposits, located some 600 km south of Lima, is now being undertaken by Pan American Commodities, S.A., a Peruvian company formed several years ago to exploit Acari and other holdings. The Acari properties are located in the Andean foothills some 50 to 60 km east of the 600-square km iron ore concession of the Peruvian Santa Corp., now being worked under a long term agreement by the Marcona Mining Co., in which the Utah Construction Co. and the Cyprus Mines Corp., of Los Angeles, are majority shareholders.

The Acari mining claims comprise 25,000 hectares of ore-bearing land on which Pan American Commodities has located twelve veins of high grade magnetite ore running 60 to 70% iron. In No. 1 vein alone an estimated 30-million tons of ore has been blocked out. The mines are located some 30 km from the Pacific Coast port of Lomas, south of the Marcona port of San Juan.

Development of the area will call for the eventual investment of an estimated US $7-million, including the construction of a 35-km railway from the mine site to Lomas, where modern port works are to be installed at a cost of more than $1-million. The plans for the new port are now being prepared by the Frederick Snare Corp., of New York, builders of the present modern portworks at Callao.

Exploitation of the Acari iron ore deposits will involve both open cut and tunneling operations and the decision to go ahead with the undertaking was taken following the completion of a comprehensive survey of the entire project made under the supervision of Roland I. Erickson, a well-known American consulting engineer. In addition to the direct investment of Peruvian and American capital, Pan American Commodities has also completed the negotiation of a series of credit agreements with investment and industrial entities in the United States and Europe.

Officers of Pan American Commodities, S.A., are: president, Anthony H. Gordon, a New York industrialist; vice president, Andres F. Dasso, well-known Peruvian industrialist and president of the Central Reserve Bank of Peru; directors, Alberto Cerritelli, a director of the Banco Union, Lima; Dr. Jose Morales Urresti, manager of the Central Reserve Bank of Peru; Dr. Guillermo Dasso, managing director of Sanguinetti & Dasso, a leading Lima lumber firm; and Col. Jean Gielgud, former Polish General Staff Officer, who served during World War II with the British 8th Army in the Mediterranean and Italian theatres. He has been awarded the French Legion of Honor and many other decorations. He has been engaged in business in Peru for the past five years.

The Acari deposits are located at around 800 to 900 meters above sea level. Total extent of the mineralized area, commercially exploitable has still to be determined, the immediate plans for development being based on the ore now blocked out. It is planned to make the first shipment of ore in the latter part of 1957 and it is expected that shipments will eventually reach 2-million tons a year.

Preliminary construction work and tunnel driving at the mine site is now being carried out by Flores y Costa, S.A., well-known Lima construction firm.

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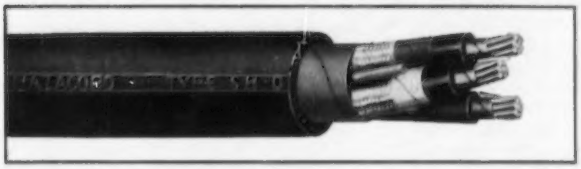

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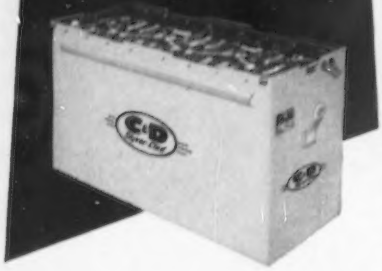

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MEXICO

The advent of uranium mining in Mexico still is far-distant but it was brought a step closer by the Mexican government's appointment in June of a three-man Nuclear Energy Commission.

Two of the men are educators with scientific backgrounds and the third member is a distinguished attorney. These men, are, of course, only to make policy recommendations to the Mexican President. The Commission is to work closely with an advisory board made up of mining men and physicists.

There still remains much to do before uranium mining will get under way but the establishment of this Commission was a first step which had to be taken.

While no commercial concentrations of radioactive ores have been reported as yet, qualified geologists have said privately that they can not conceive that such concentrations do not exist.

Several major foreign operators here presumably would be willing to undertake uranium exploration programs if there was any guarantee that they would be permitted to mine deposits their exploration discovered and would be permitted to extract a reasonable profit. However, these companies have held back thus far because uranium mining has become a nationalistic cause celebre, and in the present political atmosphere they would not have such guarantees.

Gulf Sulphur Corp. began production May 3 and operating purposely with only part of its capacity, extracted more than 9,000 tons of Frasch process sulphur during its first month. Until its storage areas at Coatzacoalcos are completed, it is using those of Mexican Gulf Sulphur.

ARGENTINA

Mineral exports from Argentina in the first two months of this year reached a value of 33-million pesos (some $800,000 at free market rates prevailing at that time), while similar exports for the same period in 1955 were worth only a half a million pesos, figures newly released by the Ministry of Finance show. This striking increase is the result of the new government's policy of allowing exports at the free market rate rather than at the previous controlled rate.

Argentine government's return to the Constitution of 1953 meant, among other things that the famous Article 40 of the Peronist version of the constitution is abolished; this article stated, "the public services belong originally to the State, and under no circumstances may they be transferred or conceded for exploitation. Those now in the hands of individuals will be transferred to the State by sale or expropriation with indemnization at a time to be determined by national law."

This move was warmly received by mining enterprises operating with foreign capital in this country:

"With the new security that capital can feel here," said one Argentine industry spokesman, "I look forward to a great new era for the Argentine mining industry—one which has been long delayed by the aloofness of foreign capital, which is indispensible in enterprises which, like mines, require large investments."

Private capital will be called on to put Argentina's only copper mine, Capillitas, back to work, according to Adolfo Factor, director of the Catamarca State School of Mines (Escuela Provincial de Mineria). Operations at Capillitas are now totally paralyzed due to "technical errors in planning," he stated. The mine is the property of the Argentine Military Manufacturing Authority (Dirección General de Fabricaciones Militares), which will call for bids from private enterprise to extract copper here, which at present will all be exported.

Mr. Factor made this announcement in a speech marking the opening of the mining school.

Plans are also in train to re-commence work at the gold and manganese mine of Farallon Negro, Factor said.

BRAZIL

With a good deal of pride, the iron ore mining company, Cia. Vale de Rio Doce, announced this week that the last payment was made on a $14-million Export Import Bank—twelve years ahead of time.

Kaiser Aluminum Co. through its Bazilian company, Kaiser Aluminum do Brasil, is starting a search for bauxite in the Federal Territory of Amapa (north side of the mouth of the Amazon River).

IN AUSTRALIA

New Broken Hill Consolidated Ltd. increased its ore reserves by 200,000 tons to 3-million tons in the year ended Dec. 31, 1955. Assay grades are little changed, the most significant move being a rise in zinc grade to 12%. At the New B.H. mine, 2.1-million tons are below No. 16 level.

During the year throughput of ore increased by 50,000 tons to 531,447 tons.

As part of the program for the development of copper mining in Australia, the Federal Government has decided to retain all features of the present tariff protection on basic copper. Concessional admission of basic copper required to supplement local production will be also retained while existing controls on basic copper and copper products for exports will continue.

Drilling at Ravensthorpe in Western Australia by Western Uranium Mines N.L. has indicated a copper body with a reserve of more than 4-million tons of ore averaging 1.6% copper. Of this, 1.25-million tons average 4% copper and an estimated 1 dwt gold a ton. Drilling has also indicated, at a lower horizon, a second large orebody. The exploration program is continuing and a successful

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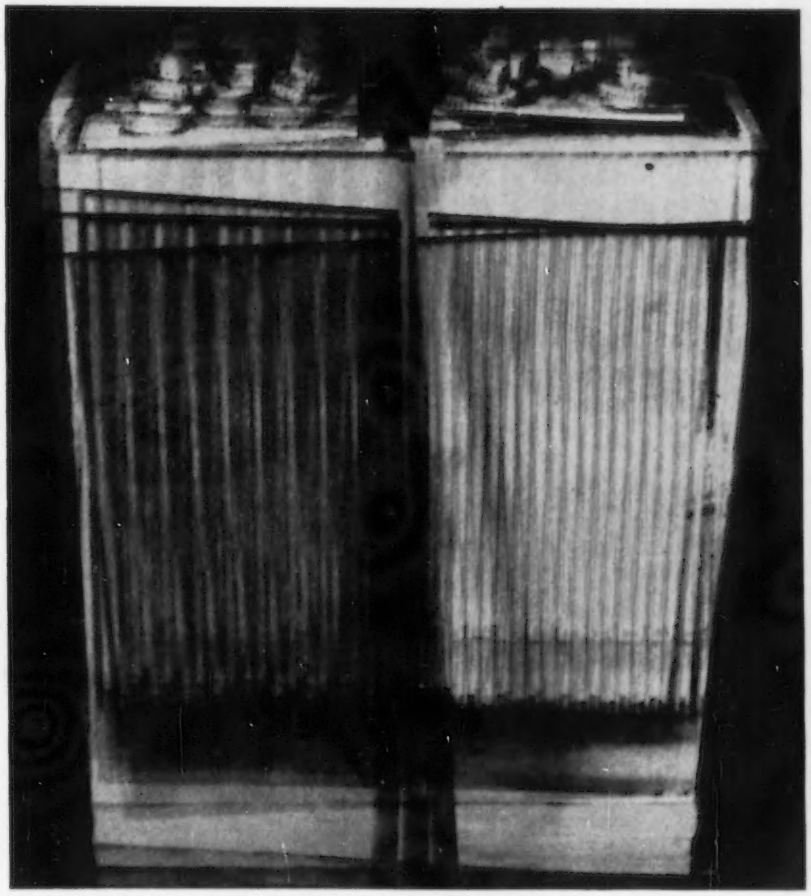
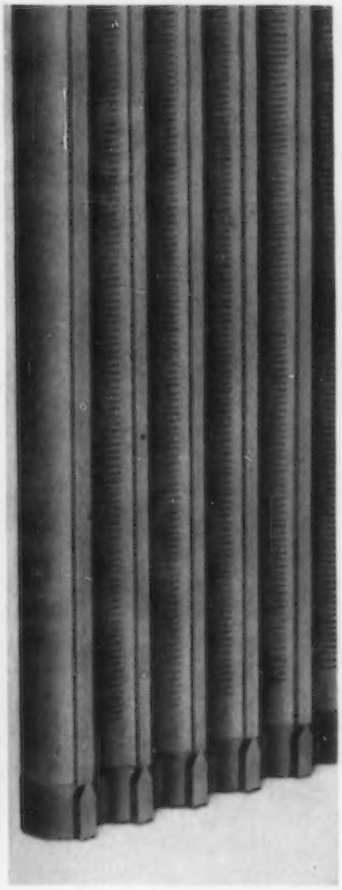


Actual photo taken during vibration torture test on an Ironclad Battery



Section of Ironclad positive plate

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Australia *(Continued)*

outcome may lead to the erection of a copper smelter and treatment operations. The treatment plant at present being installed is of small dimensions and capacity. It will come in operation early in 1957. The company's name will be changed to Ravensthorpe Copper Mines N.L.

Australian Mining & Smelting Co. Ltd. is all-out to prove commercial quantities of low grade lead in the close vicinity of the well-known Rum Jungle uranium field. Company is a subsidiary of Consolidated Zinc Corp. Ltd. whose other subsidiary is developing the Rum Jungle uranium field under contract from the Australian Government. Strong signs of a big deposit of lead around the uranium mine area have been reported but the grade was described as very poor. Several months of diamond drilling operations in an area involving 340 acres are planned to test the value of deposits.

Western Titanium N.L. expects that its new plant at Capel in Western Australia will be operating at half capacity before the end of 1955. An increased capacity is expected early in 1957. Option rights have been obtained by Western Titanium over about 2,000 acres in which scout boring has indicated several million tons of payable ore reserves. Check boring is now in progress.

Great Boulder Pty. Ltd., large gold mining operator, is raising £A500,000 to finance its development program. The new money will be used for sinking an internal shaft in the Edwards shaft section and deepening Hamilton shaft following encouraging drilling and development results. Development of the southern end of the eastern lode system and a haulage system between Edwards and Hamilton shafts are also planned. The new areas are expected to open up a large tonnage of new ore.

United Uranium N.L. has exposed ore assaying 6.52% uranium oxide on its El Sharana lease. This was met at the same level (57 ft) in No. 1 shaft as the one-ton piece of pitchblende assaying between 83 and 87% oxide which was mined recently.

IN THE PHILIPPINES

Atlas Consolidated reports its April production as 159,820 tons of ore milled averaging 0.83% copper. Concentrates totalled 4,664 tons averaging 21.4% copper and 0.13 oz gold per ton, containing nearly 2-million lb of copper. During the nine months of operation in 1955 the Atlas mill treated 1,013,600 tons of ore averaging 0.93% copper with an average extraction of 82.7%. Total shipments of copper concentrates amounted to 12,480,913 lb copper and 3,580 oz gold, with a gross sales value of over $4.8-million. Except for one shipment to the U.S. all concentrates were made to Japan for smelting. Copper was sold abroad but the gold was returned to Manila for sale in the local market. Ore reserves at the end of 1955 were reported at 68.5-million tons averaging 1% copper. This estimate was verified in 1955 by R. L. Loofbourow, senior mining engineer of E. J. Longyear Co. of Minneapolis. The Toledo mill was treating 6,000 tpd in March, with intention to increase its capacity to 10,000 tons by the end of 1956.

The company is planning to build an acid and fertilizer plant in 1957 in Toledo to utilize the flotation pyrites recovered as by-product in the mill, which now totals 350 tpd. Ultimately the plans include production of superphosphate and gypsum to be sold to local cement mills which are obliged to import this product.

Gold production ended in February at San Mauricio Mining Co. because of heavy operating losses in 1955 and depleted ore reserves. Since its rehabilitation after the war San Mauricio had been the largest gold producer in the Paracale area, with an output in 1954 valued at over $2.6-million from ore averaging 0.37 oz per ton. In 1955 production fell to half that figure and ore values declined to 0.2 oz per ton. As a result an operating loss of $760,000 was sustained. Development work during the year failed to locate any substantial tonnage of profitable ore.

Suspension of work at San Mauricio reduced the number of gold mining operations in the Philippines to six, not including by-product gold recovered by Lepanto Consolidated from its copper ores.

Herbert Allen, new chairman of Benguet Consolidated, has promised President Magsaysay that his banking organization will embark on a large scale investment program in the Philippines amounting probably to millions of dollars involving new mining enterprises to employ Benguet's technical staff. The annual report of Benguet revealed substantial improvement in 1955 with net profit of over $1-million. Its subsidiary, Balatoc, likewise reported profits of over $188,000 against a loss in 1954.

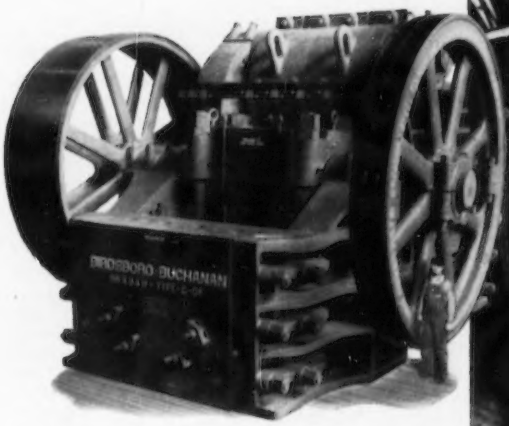
Acoje Mining Co. will place orders for $400,000 worth of machinery and equipment in the United States. Company is a substantial producer of metallurgical grade chromite and shipped 8000 tons in April valued at over $205,000. Robert Jones is consulting geologist for the company.

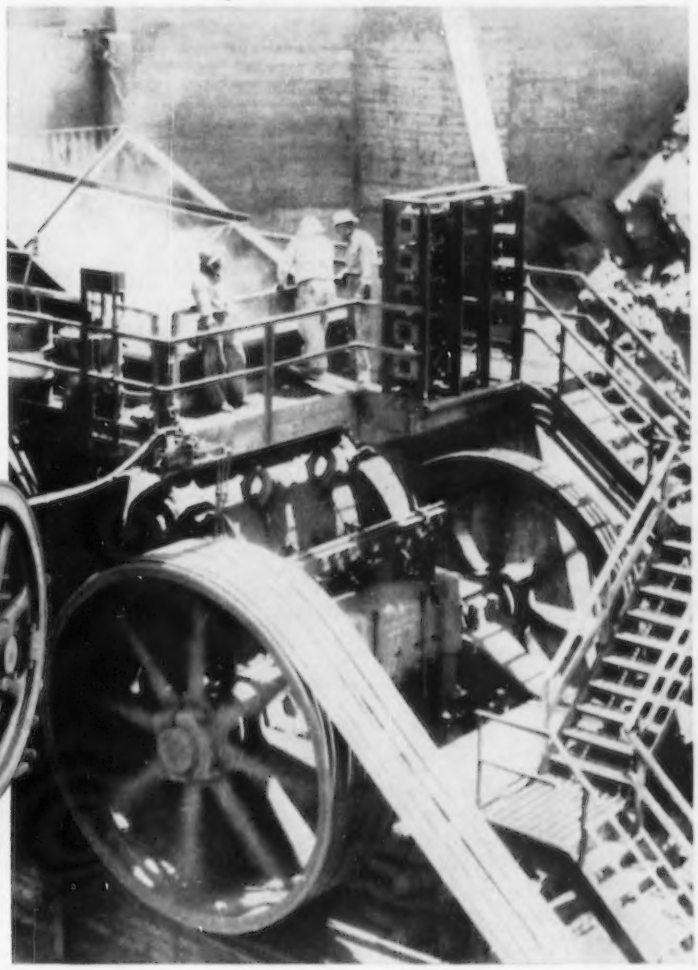
Palawan Quicksilver Mines, the country's only mercury producer, reported its 1955 output totalled 661 flasks, valued at $175,000. Total ore reserves are estimated at 319,000 tons, valued at over $4-million. Current production is about 220 flasks per month.

Elizalde & Co., manager of Samar Mining Co. has received an offer from a foreign mining company to develop its deposit

BIRDSBORO-*Buchanan*

Giant Crusher Chews Up Ore in Peru at Top Rate of 1000 Tons Per Hour . . .





DESIGNERS AND BUILDERS OF:

- STEEL MILL MACHINERY
- HYDRAULIC PRESSES *(Metalworking and Extrusion)*
- CRUSHING MACHINERY
- SPECIAL MACHINERY
- STEEL CASTINGS
- Weldments "CAST-WELD" Design
- ROLLS: Steel, Alloy Iron, Alloy Steel

• This Birdsboro customer turned a barren wasteland in Peru into a mushrooming iron mine in just four months. The ore from the approximate 70-million ton deposit is being broken in this mammoth 66x84-in. Birdsboro-Buchanan Deep Frame jaw crusher. One of the largest ever built, the crusher incorporates special Birdsboro-Buchanan design features. This ruggedly built machine's great depth and exceptional length of crushing surfaces provides fast, high production with minimum maintenance. Ask your Birdsboro representative to explain the exclusive Birdsboro-Buchanan features that make this possible.

CR-11-56

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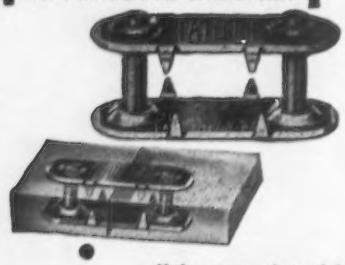
New York Office: **Engineering Supervision Co.,** *120 West 42nd Street, New York 36, N.Y.*

PLATEGRIP
PLATE FASTENERS FOR CONVEYOR BELTS



Make strong dust-tight, water-tight joints in belts of any width. Special design spreads tension uniformly across belt, allow natural troughing of belt and assures smooth operation over flat, crowned or take-up pulleys. Sizes for belts of from 1/4" to 1 1/2" thickness. Write for Catalog Sheet.

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Philippines *(Continued)*

of nickel ore on Homonhon island on a royalty basis. The ore is said to average 0.5 to 1.6% nickel content.

Baguio Gold Mining Co., one of the few remaining gold producers in Mountain Province, has signed an operating contract on a graduated royalty basis to develop the property of the Gold River Mining Co. Prospects are considered good for bringing in a new producer.

IN AFRICA

Southern Rhodesian mineral production should reach a total value for 1956 of $70-million, a record for the country, the Chamber of Mines of Rhodesia has stated. The statement followed the announcement of a record production for April of minerals worth $6-million. April figures showed a rise of about $400,000, chiefly accounted for increases in asbestos production.

Mineral production in Southern Rhodesia comes almost entirely from a large number of small mines, some of which are still worked by individual prospectors. With the exception of the colliery at Wankie the country has still no single large mining enterprise.

Anglo American Corp. reportedly has exercised its option over the ilmenite sands undertaking near the $5.6-million titanium pigment plant to be built by African Explosives and Industries at Natal.

Opening of Kinross goldfield's first mine is making good progress, with two companion ventilation winzes going down. One is expected to intersect reef at 700 ft and the other at 1200. Some 2,000 ft of sinking is finished. Initial plant capacity is set at 60,000 tons per month.

South Africa will be able to sell uranium at a profit when contract buying ceases, according to estimates by the secretary of the South African Atomic Energy Board. Full production from the 27 gold-uranium mines is expected in 1960.

Doornfontein G.M. has topped its own 1508-ft tunneling record (March 1956) with a new mark of 1903 ft of straight driving and 59 ft auxiliary in 26 days of April. No new techniques were used, the increase is credited to improved teamwork.

IN EUROPE

ISLE OF MAN

Amanda Mines Ltd., announced plans to acquire Metaliferous Holdings Ltd., a lead-zinc-copper operation subject to approval of Amanda shareholders. Property has a Mill with 120 tpd capacity and rights to two mines (the Snaefell and Foxdale properties). Present operation is on salvaging dumps of Foxdale mine (a reported 400,000 tons).

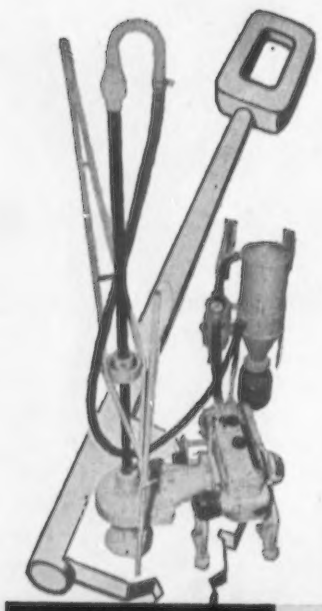
Amanda plans to build an additional mill of the same capacity. Profits of the stepped-up salvage operation will underwrite an intensive exploration and development drive—in the Foxdale and Snaefell areas, as well as in other prospects now being negotiated with local governments.

Ore deposits of the Isle of Man, the announcement states, have not previously been investigated by present-day geophysical methods.

ITALY

Existence of important potash beds in Sicily, discovered last year, has been confirmed. While studies were being made on the contents of some sulphur mines, the engineers of the Montecatini Co. found a deposit of kainite containing some 25-million tons, at Bosco near Serra di Falco.

Last year Trinacria and Edison Companies, affiliated to the Alsatian Potash Company, discovered at Villapriolo (Enna) and at Salinella (Caltanisetta) beds of scheelite and carnalite. It is reported that Montecatini Co. has patented a process for separating sulphate of potash from magnesium and is studying its introduction on an industrial scale. Process consists in floating the ore in a saturated solution which separates the kainite from the other salts.



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- Ideal for exploration drilling.
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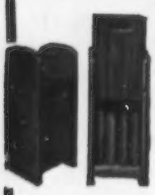
HAMMOND'S SAFE BLASTING EQUIPMENT

EXPLOSIVE BOXES



These rigid non-conductive explosive boxes represent a prime safety investment. Made entirely of wood-tongue-grooved and dove-tailed construction . . . no metal parts . . . automatic lock . . . rubber band spring . . . moisture-resistant. Box sizes are based on 1¼ x 8" sticks.

WOOD TAMPING POLES

For Tamping Explosive Shots: Poles are round, made of Hardwood. Sizes to 10' long.

SECTIONAL TAMPING POLES

These poles are made of straight grained wood and are coupled together with removable wood pins held in place in recessed grooves by a rubber band and can be quickly connected and unconnected. Couplers and Head Blocks are 4, 5, and 6 inches in diameter. Please specify size when ordering. Poles are 1½" in diameter.

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Spangler, Pa.—Catalog on Request

IT'S "HOME, HOME ON THE RANGE!" for RUGGED EAGLE LOG WASHERS

A number of Eagle Double Log Washers are producing profitably on the Mesabi Range—and other iron mining areas.

Eagle Logs are built and designed to scrub, abrade and wash maximum capacities of iron ore and other ores, 'round the clock, all season long.

Sturdy, non-deflecting tubular steel log shaft, replaceable Ni-Hard paddle shoes, totally enclosed gearing running in oil-bath, water-lubricated lower bearings—Timken upper thrust bearings, are a few features that insure top performance and economy. 36" and 48" dia. paddles (tip to tip); 7' and 9' 4" tub widths; 20', 24', 30' lengths.

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FINE MATERIAL WASHERS · LOG WASHERS · "SWINTON" OREDOG LADDERS · BREAKER BALLS & PILE HAMMERS

EIRE

Pumping has begun at the abandoned copper mines at Allihies, County Cork, less than a week after it was announced that a Canadian mining group was interested in the copper deposits there.

The pumping contractor in charge said that clearing the old shafts of water would take several weeks. When this has been completed, preliminary exploratory work would be started at the Can-Erin Mining Co., Toronto.

Chairman of Silvermines Lead and Zinc Co., County Tipperary, G. E. Russell, has informed shareholders certain Canadian Mining interests (Mogul) are interested in acquiring the property for large-scale development. He added that if acceptable proposals were received these would be submitted immediately to the stockholders. The mines in question are located at Shallee, County Tipperary.

An aerial survey of certain areas in County Mayo, is to be undertaken by a third group of Canadian mining experts with a view to exploring its mineral resources.

IN ASIA

JAPAN

A contract to supply 105,000 tons of Japanese alumina to the U. S. annually for ten years has been approved by the Japanese Government, the Japan Light Metal Co. announced. Harvey Machine Co. was making arrangements with the U. S. Government and comercial banks to complete the deal, the company said.

Under the contract, Japan Light Metal and the Sumitomo Chemical Industrial Co. would supply 55,000 and 50,000 tons of alumina respectively each year for ten years, starting from 1958. The contract could be altered after five years on 18 months' notice.

Alumina will be used for aluminum production at a refinery which Harvey Machine Co. plans to build at Dallas, Oregon. The American company would make an advance payment of $1.4-million to the two Japanese companies for an expansion.

CEYLON

The new Government has decided to exploit extensive ilmenite-bearing deposits in north east coast of Ceylon as a state venture, and not to sell exploiting concession to private enterprise, local or foreign. This decision is in spirit with policy of the new government—all basic industries should be state-owned and controlled.

The Government does not intend to ship the crude sand, but to establish a refining and ore dressing plant at the site itself.

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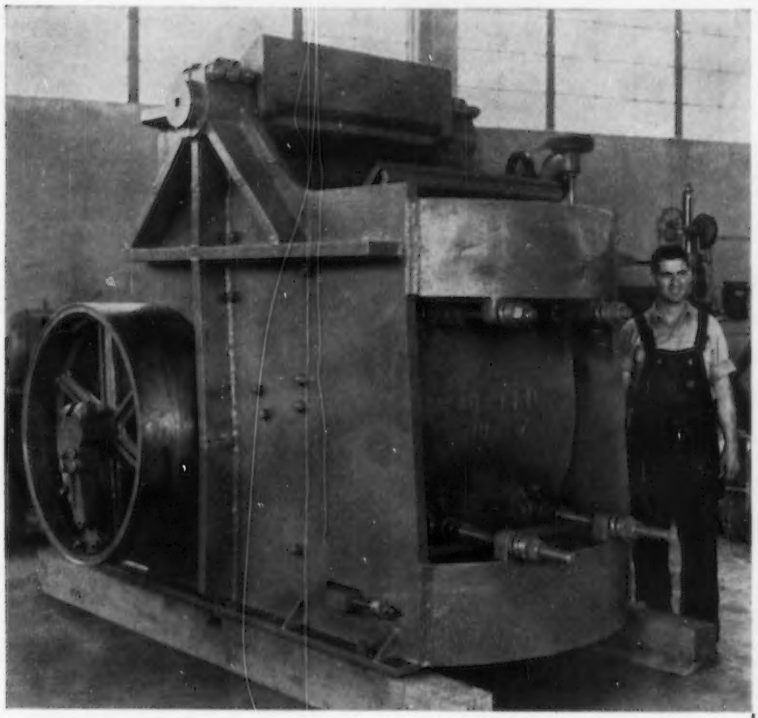
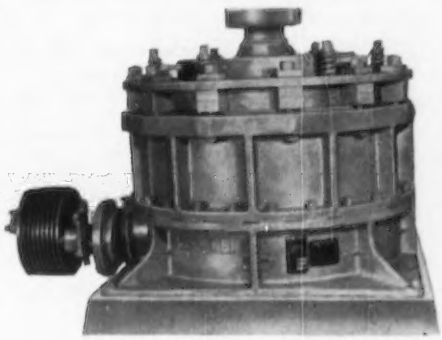
Lowest cost-per-ton crushing with KUE-KEN CRUSHERS



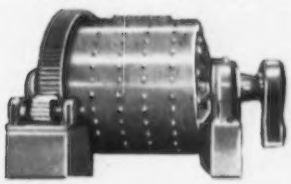
KUE-KEN JAW CRUSHERS . . . "Crushing without rubbing" lengthens jaw plate life 5 to 10 times. Uses less power. Self-lubricated with crankcase-type system. Flywheel safety device eliminates frame breakage. Sizes: 12″ x 7″ to 48″ x 36″.



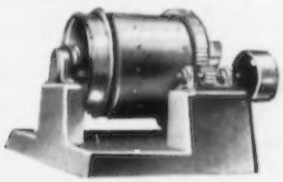
KUE-KEN GYRATORY CRUSHERS

Compact design requires less headroom — takes choke feed. "Crushing without rubbing" gives longer life. Sizes: 18″; 28″; 36″.

RIB-CONE BALL MILLS
MORE THAN 100 SIZES AND TYPES



Grate discharge mill also available in plain, overflow, screening and convertible types with capacities from 25 to 500 tons per 24 hrs.



Screening mill for amalgamating classes of ores. Capacity—2 to 95 tons per 24 hrs.

Single end peripheral discharge rib cone mill fitted with water-cooled feed bearing for handling hot kiln product.

Peripheral discharge mill for producing granular product. For controlled grinding of tungsten and similar ores where sliming must be eliminated.

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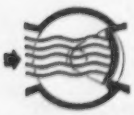

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THIS EXCLUSIVE ECCENTRIC PRINCIPLE ACCOUNTS FOR THE OUTSTANDING PERFORMANCE OF DeZURIK VALVES ON SO MANY SERVICE LINES.

ECCENTRIC PRINCIPLE

The DeZurik Valve combines an eccentric-shaped plug and an eccentric-raised seat in the valve body. The slightest rotation of the plug breaks the contact and it swings open with an easy quarter-turn.

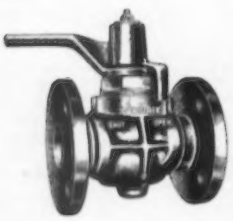
NO LUBRICATION

Because there is no friction between the plug and the valve body, NO LUBRICATION IS REQUIRED. The danger of contamination from lubrication of the plug is eliminated in DeZurik Valves.

RESILIENT-FACED PLUGS

Metal-cored plugs are available with a variety of synthetic facing materials. These resilient plug-facings seal around solids in the flow — effectively eliminating leakage even on lines carrying solids in suspension.

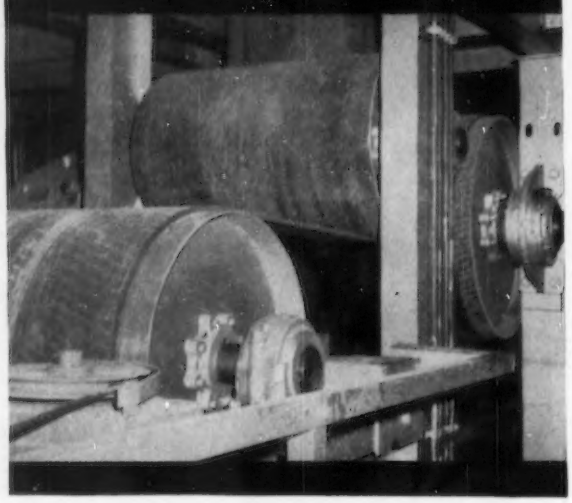
Test a DeZurik Valve—prove its efficiency—on lines carrying pulp, tailings, slurries, wash water . . . on ANY line where tight shut-off and quick, easy operation are required. In sizes from ½" thru 20"; manual, pneumatic, hydraulic or electric operators; with flanged, screwed or victaulic ends. Representatives in principal cities.



OR WRITE

DeZURIK SHOWER CO. Sartell, Minn.

TURNING POINTS—



Wherever conveyor belts *turn over*, industry *turns to* the American Pulley Company. From pit or mine to crushing . . . to processing . . . in and out of storage . . . a high portion of recent installations are equipped with American Conveyor Pulleys.

Engineers and operators know they will get pulleys:

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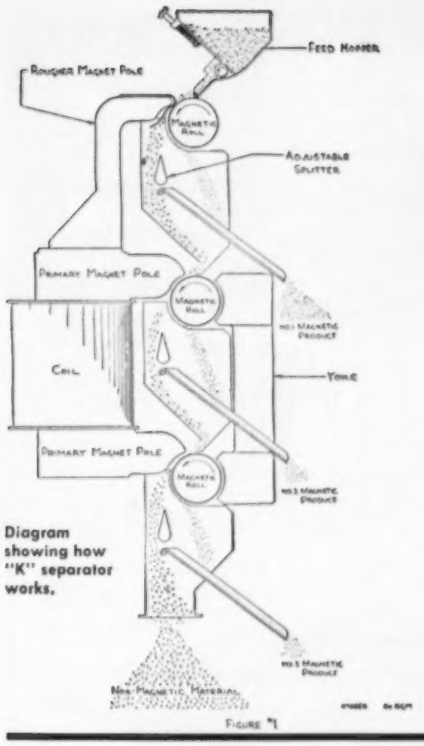


Diagram showing how "K" separator works.

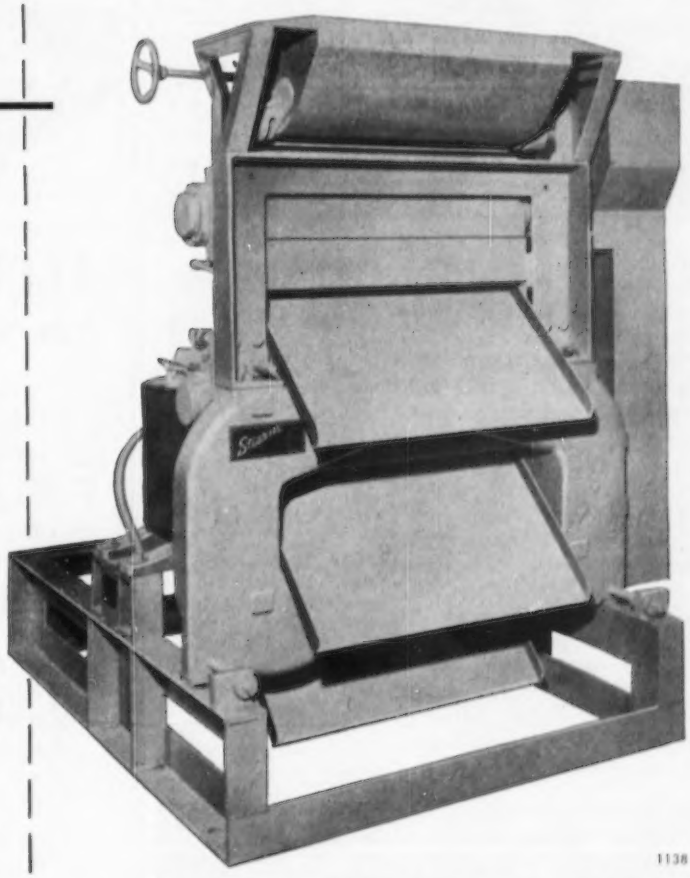
FIGURE "1

Purifies and concentrates minerals where other methods fail

STEARNS HIGH-INTENSITY MAGNETIC SEPARATOR

Stearns Type K magnetic separator provides an intensely powerful magnetic field which attracts very feebly magnetic particles. That is why the "K" has proved highly successful in purifying and concentrating minerals when other methods were either impractical or inadequate.

Users report that this separator has given outstanding results for magnetically cleaning or concentrating materials ranging in size from 10 to 200 mesh. Capacity ranges from 80 to over 500 lb per hr per inch of feed width. "K" separators are built in 10, 20 and 30-in. feed widths and can be furnished with from 2 to 7 magnetic fields. Complete laboratory facilities available for testing samples of your product. We invite comparison of results. Write today for bulletin 701B.



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FEATURES THAT PUT THE "K" OUT FRONT:

1. Magnetic field protected against flux leakage
Magnet support frame is not part of magnetic circuit. Specially constructed steel rolls with non-magnetic stub shafts further insulate magnetic circuit.

2. Simple adjustment
Positive, easy control of feed rate, air gap width, splitter settings for extremely accurate separation. So simple, unskilled workers can operate and adjust it.

3. Uniform material distribution
Louver-type feeder provides uniform distribution across entire feeder width. Speed of feed closely matches roller speed for greatest efficiency.

4. Powerful magnetic force
Primary pole noses are scientifically shaped to give maximum flux density in separating zone—take full advantage of powerful electro-magnetic force.

5. Dependable, long-lasting
Triple-sealed bearings keep out dust, insure smooth, low-cost operation. All parts are easily accessible for service.

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- Scheelite
- Soda Ash
- Abrasives
- Silicon Carbide
- Aluminum Oxide
- Pottery Clay
- Fire Clay
- Kyanite
- Nefheline Syenite
- Barite

Product Concentration
- Manganese Minerals
- Ilmenite
- Monazite
- Chromite
- Columbium Ores
- Tantalium
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MAGNETIC EQUIPMENT FOR ALL INDUSTRY

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STEARNS MAGNETIC, INC., 624 S. 28th St., Milwaukee 46, Wis.

NEW
TeeCee One-Pass
carbide drill bits

COST HALF THE PRICE OF OTHER CARBIDES . . . HAVE CUT DRILLING COSTS UP TO 75%

HERE'S THE PROOF

RESULTS OF TESTS IN CANADIAN MINES

MINE TESTS	FORMER COST PER FT. DRILLED WITH OTHER CARBIDES	COST PER FOOT WITH TEE-CEE ONE-PASS CARBIDE BITS	COST SAVINGS PER FOOT	PERCENTAGE SAVING PER FOOT	SAVING ON EVERY 100,000 FT. OF DRILLING
"A"	8.2¢	2.06¢	6.14¢	74.87%	$6,140.
"B"	11.3¢	5.07¢	6.23¢	55.13%	$6,230.
"C"	8.0¢	7.15¢	.85¢	10.51%	$ 850.
"D"	3.2¢	2.7 ¢	.5 ¢	15.6 %	$ 500.
"E"	4.5¢	2.0 ¢	2.5 ¢	55.5 %	$2,500.
"F"	9.6¢	6.3 ¢	3.3 ¢	34.37%	$3,300.

The revolutionary new "Tee-Cee One-Pass" Carbide Drill bit costs less than half the price of other carbides—you drill it to destruction, then throw it away. Tested and proven in 35 Canadian mines, it cuts costs in almost every case . . . up to 75% in one test. The "Tee-Cee One-Pass" carbide bit earns additional savings, too. It eliminates time wasted in transporting worn bits to the surface . . . does away with the cost of grinding time and equipment. Test this bit on your own operation. Write to: Thompson Products Limited, Mining Division, St. Catharines, Ontario, Canada.

New "Tee-Cee One-Pass" Carbide Bit can be used with existing steels. Simply cut off solid carbide tip or thread and forge, grind or machine your steels to an 11 degree taper. New brass shim makes fitting and knock-off easier.

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Easy to carry—just 35 lbs.

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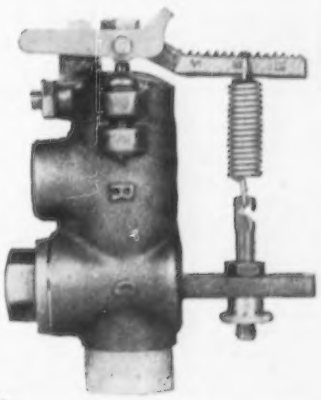

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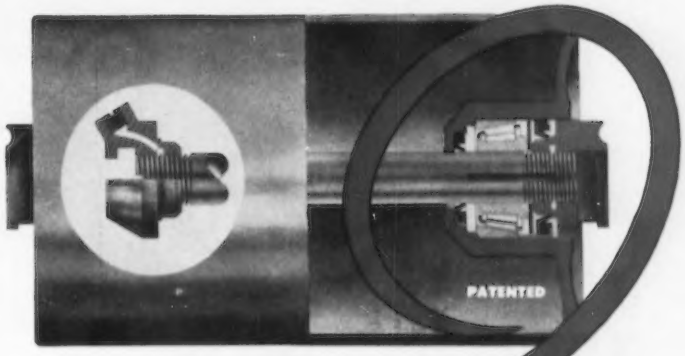
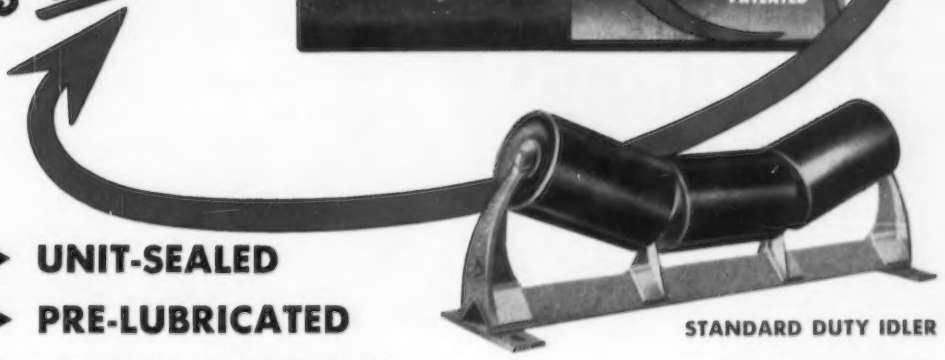
(This index is published as a convenience to the reader. Every care is taken to make it accurate, but E&MJ assumes no responsibility for errors or omissions.)

UST* Continental Idlers

*** UNIT-SEALED PRE-LUBRICATED TIMKEN BEARINGS**

Saves Grease!
Saves Labor!
Saves Belts!





STANDARD DUTY IDLER

UNIT-SEALED
PRE-LUBRICATED
TIMKEN BEARINGS

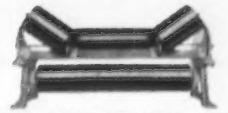
Continental's Unit-Sealed "UST" Conveyor Idlers, incorporating Timken Bearings, Garlock Klozures, are the answer to the operator's prayer.

The Unit Bearing Assemblies—"sealed unto themselves" provide an ample but not excessive grease reservoir. This represents a saving of grease and further eliminates any possible migration of the grease from upper to lower bearings on inclined rolls. The lubricant is a top quality water repellent grease of a stable consistency with a wide temperature range for long life.

Most important—this construction permits operating the Continental "UST" Idler without relubrication for 1-2-3 years depending upon the severity or character of conditions.

SELF-ALIGNING FLAT BELT IDLER

RUBBER DISC IMPACT IDLER



GRAIN CONCENTRATION IDLER

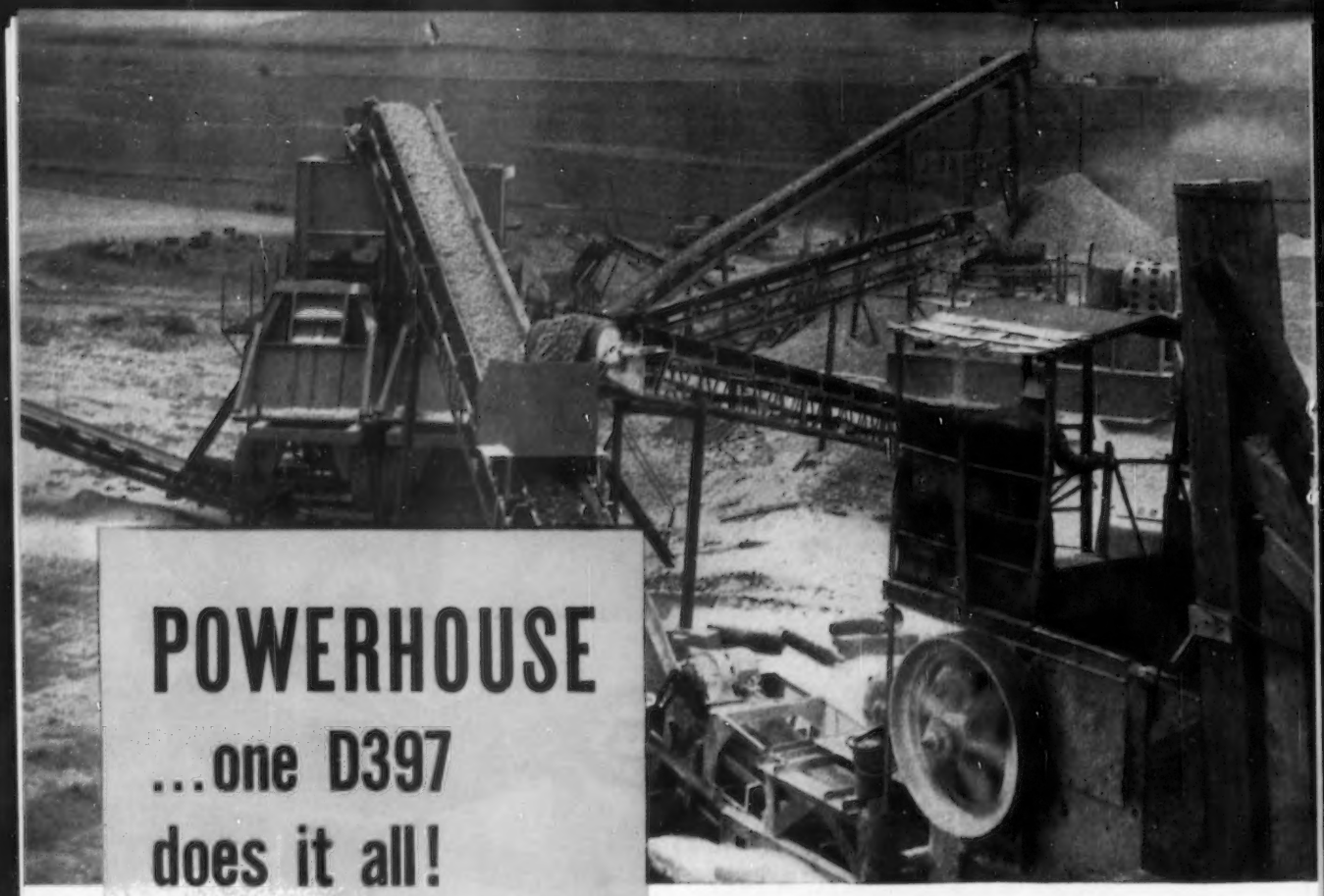
SELF-ALIGNING TROUGHING IDLER

***Long Life*- THE ULTIMATE IN MINIMUM MAINTENANCE**

CG—5209

INDUSTRIAL DIVISION
CONTINENTAL GIN COMPANY
BIRMINGHAM, ALABAMA

ENGINEERS CGC ATLANTA • CLEVELAND • DALLAS • KNOXVILLE CGC MANUFACTURERS
MEMPHIS • NEW YORK 17, NEW YORK



POWERHOUSE ...one D397 does it all!

In one of the world's largest phosphate beds, near Soda Springs, Idaho, this CAT* D397 Electric Set is the main source of power for the crushing plant shown here. Output of the crusher, owned by Morrison-Knudsen Co., Inc., is 1000 tons per eight-hour day of 1½"—⅜" quartzite. The crushed quartzite is raw material used in Monsanto Chemical Company's nearby elemental phosphorus plant.

The D397 Electric Set furnishes power for a 125 HP motor on the Simmons cone crusher, a 100 HP motor on the Cedarapids jaw crusher, and nine motors totaling 172½ HP on conveyors and vibrator screens.

Now there is a new Caterpillar D397 Electric Set with Turbocharger, developing 350 KW. It is self-regulated for easy, adjustment-free operation and steady voltage. It incorporates Caterpillar's amazing new generator, which exactly matches the D397 Engine powering it.

Reliability and long life are important in an electric set, which is often called upon for continuous operation. The Caterpillar D397 has both, with such features as aluminum alloy bearings, "Hi-Electro" hardened crankshaft and cylinder liners. It also has highly effective oil and air filters designed to protect the engine's Caterpillar-built precision under even the dustiest conditions.

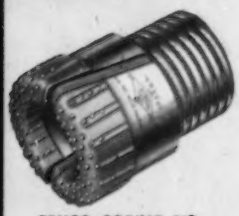
There is a complete line of Caterpillar portable and stationary Electric Sets, up to 350 KW. Your Caterpillar Dealer — who provides skilled service and parts you can trust — has full details on the engine or electric set best suited to *your* operation. See him today.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

MODERN HEAVY-DUTY ELECTRIC SETS



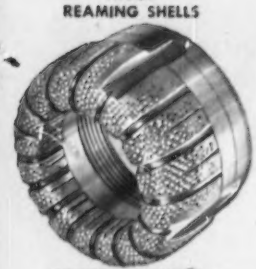
TRUCO CORING BIT

TRUCO CONCAVE BLAST HOLE BIT

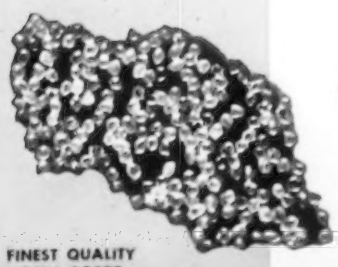
TRUCO PILOT BIT

TRUCO IMPREGNATED CORING BIT

TRUCO REAMING SHELLS



TRUCO STANDARD OIL FIELD BIT



FINEST QUALITY DRILL BORTZ

in the American tradition

Twice a day a quick transformation overtook the old frame garage on John R Street, Detroit. At seven in the morning, the doors swung open, a spindly car chugged out and the garage became a busy little workshop. Some time after dark, the car was driven back in and, for a few hours, the workshop was a garage again.

As a workshop, it had for us a very special significance—it was here that our Company came into being and set up the first local shop devoted exclusively to making industrial diamond tools.

But, far more important, it was the first place in the whole midwest where industry could find a complete stock of fine industrial diamonds, imported direct to Detroit, and superior to stocks previously available only in New York.

Such convenience is taken for granted nowadays and the mails deliver thousands of our diamond selections yearly, but, in those days, it was an innovation and so useful that in almost no time at all, the old frame garage (which had cost $50.00) needed a 12-foot addition (which cost another $50.00).

And, that was but the beginning. Today, our plants are the most modern in the industry and in the intervening 46 years our laboratories have pioneered many of the most significant innovations in diamond tool technology, including *Engineered Diamond Tools** and Truco Engineered Diamond Bits.

And, today, in every major drilling operation throughout the world, Truco Engineered Diamond Bits enjoy a unique reputation for fast, accurate, dependable cutting in any formation and for their ability to deliver important economies in rig time and footage costs. May we send you the Truco Diamond Bit Catalog?

**Engineered Diamond Tools* are diamond tools *engineered* to the job and *guaranteed* to do it.

TRUCO DIAMOND BITS

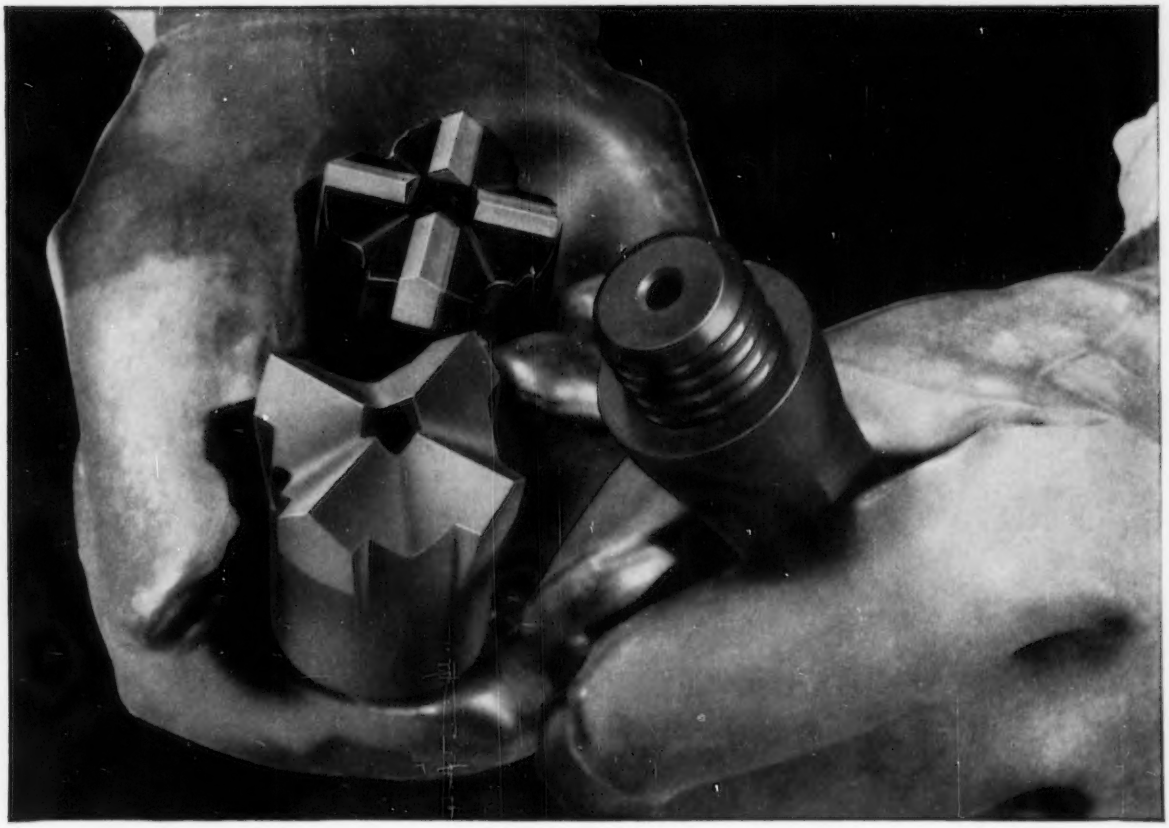
by

WHEEL TRUEING TOOL COMPANY

3200 W. Davison Avenue, Detroit 38, Michigan

WHEEL TRUEING TOOL CO. OF CANADA, LTD.
575 Langlois Avenue, Windsor, Ont., Canada

Use the same drill steel –just switch the TIMKEN® bits



TIMKEN® interchangeable rock bits let you switch bit types without switching drill steels

TIMKEN® interchangeable bits do away with the old-style, time-wasting chore of changing drill steels every time bit types are switched. Now drillers use the same drill steel, easily and quickly switch Timken bits as the ground changes—right on the job. Dozens of Timken bits, both multi-use and carbide insert, fit the same drill steel. It takes only a minute or less to unscrew one Timken bit and screw on a different one. Work keeps moving by using the most effective and economical bit for the ground conditions.

And savings mount. You can cut costly drill steel inventory. You get long, economical bit wear because Timken bits are made from electric furnace Timken fine alloy steel. We're the only American rock bit manufacturer that takes this extra quality control step. And Timken bits have a shoulder-union especially developed by the Timken Company that keeps drilling impact from damaging threads.

Our rock bit engineers will gladly help on your drilling problems. They'll put their more than twenty years of experience to work to help you cut your drilling costs. Just write: The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable address: "TIMROSCO".

WHERE YOU CUT COST WITH TIMKEN MULTI-USE BITS

Most economical for ordinary ground. With correct and controlled reconditioning, they give the lowest cost per foot of hole when full increments of steel can be used.

WHERE YOU CUT COST WITH TIMKEN CARBIDE INSERT BITS

Give highest speed through hard, abrasive ground. Also most economical for constant gauge holes, small diameter holes, very deep holes.

your best bet for the best bit...for every job

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.